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ABSTRACT

The hardware and software system used to create the National Opinion Research Center/Center for Research on Evaluation, Standards, and Student Testing (NORC/CRESST) item databases and test booklets for the 12th-grade science assessment are described. A general description of the capabilities of the system is given, with some specific information about how to use the system. A user's guide for accessing the item databases and producing camera-ready copy is included. TESTBUILDER is the system developed for constructing item databases and producing copy for booklet production. Two programs (FILEVISION IV and TEXTURES) must be purchased to access the system and produce copy. From the databases, test items can be extracted to be included in booklets. Appendix A is the key to the comprehensive index of science assessment materials' codes. Appendix B contains test booklets from the science assessment study in six forms (each with easy, intermediate, difficult, and more difficult test booklets) in earth science, physics, chemistry, and biology. (SLD)

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National Center for Research on Evaluation, Standards, and Student Testing

Final Deliverable – November 1992

Project 2.6: Analytic Models to Monitor Status & Progress of Learning & Performance & Their Antecedents: The School Science Assessment Project

Documentation of Assessment Instrumentation— The NORC/CRESST 12th Grade Science Assessment, Item Databases, and Test Booklets

- UCLA Center for the Study of Evaluation

in collaboration with:

- University of Colorado
- NORC, University of Chicago
- LRDC, University of Pittsburgh
- The RAND Corporation

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Documentation for

the
NORC/CRESST 12th-Grade Science Assessment

Item Databases
and
Test Booklets

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Appendix A: Key to comprehensive index of science assessment materials' codes

Appendix B: Test booklets from the 12th-grade science assessment study

This document describes the hardware and software system used to create the NORC/CRESST item databases and test booklets for the 12th-grade science assessment study. It provides a general description of the capabilities of the system and some specific information about how to use the system. It also includes a user's guide for accessing the item databases and producing camera-ready copy.

1 TESTBUILDER

TESTBUILDER (Zimowski, 1991) is the system we developed for constructing item databases and producing typeset camera-ready copy for booklet production.

1.1 System components

Hardware for the system includes:

1. Macintosh IIci with 4 megabytes of RAM
2. Hewlett-Packard Scanjet Plus scanner
3. LaserWriter IINT

Software for the system includes:

1. OMNIPAGE, an optical character recognition program
2. SUPERPAINT, a collection of drawing and painting tools for editing and creating graphics
3. FILEVISION IV, a database management system
4. $\TeX$TURES, an adaptation of the $\TeX$ typesetting program for the Macintosh
5. To$\TeX$open and To$\TeX$multiple, programs for exporting items from the FILEVISION databases in "$\TeX$tures" format
6. MULTIPLE and OPENEND, programs for producing typeset camera-ready copy

1.2 System capabilities

TESTBUILDER is capable of assembling item sets from many sources, storing the items in a richly cross-indexed database, and drawing items from the database for typesetting, page formatting, and printing of camera-ready copy. Once the source material has been scanned, cleaned, and entered in the database, the camera-ready copy for the selected items is prepared with a minimum of human intervention and no manual cutting and pasting of the figures. The program's expert system optimally arranges the items on the pages and automatically inserts the item graphics in the text.

The figures on the following pages show the results of the process. Figure 1 is a Xerox copy of an item from the New York State Regents Examination just as it appears in the test booklet. Figure 2 shows the text of the item after it has been scanned and converted to machine-readable characters by OMNIPAGE. As the statistics at the bottom of the figure show, the program interpreted the text without error.

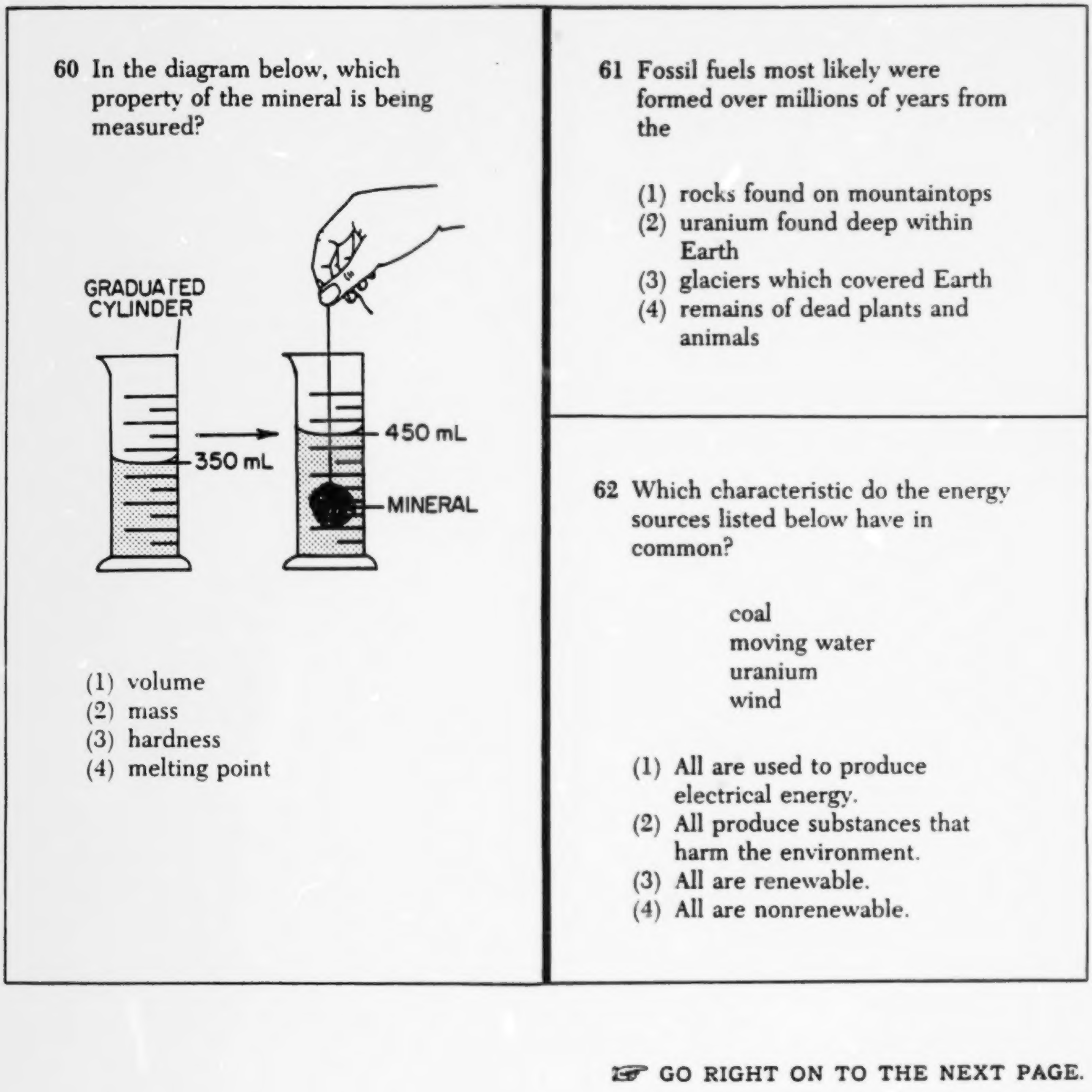
Figure 3 shows the bitmap of the graphic portion of the item produced in the initial scanning. Figure 4 shows the graphic after it has been cleaned and edited using SUPERPAINT. Figure 5 shows the entry for this item as it appears in the FILEVISION IV database. In this form any item in the database can be viewed on the monitor virtually instantly for purposes of selecting items for the test. Camera-ready copy for the test form is created simply by supplying the item numbers to the system, which automatically generates all of the typesetting and formatting commands and produces the copy shown in Figure 6.

FILEVISION IV is quite flexible, with few internal limits on storage. It is capable of storing an almost unlimited number of items and item-information fields. Subsets of items can be selected based on the entries in one or more of the item-information fields.

1.3 System specifications

The item text and item information must be entered in the FILEVISION database in ASCII format. They may be directly typed into the database or imported from external ASCII files, such as those produced by OMNIPAGE. Provided that the external ASCII file contains proper field and record delimiters, any number of items and item-information fields may be imported into the database in a single run.

The text of the items in the database must follow a specific format for the procedures to work. The formats for multiple-choice and open-ended items differ slightly; both are described below.



60 In the diagram below, which property of the mineral is being measured?

GRADUATED CYLINDER
450 mL
350 mL
MINERAL

(1) volume
(2) mass
(3) hardness
(4) melting point

61 Fossil fuels most likely were formed over millions of years from the

(1) rocks found on mountaintops
(2) uranium found deep within Earth
(3) glaciers which covered Earth
(4) remains of dead plants and animals

62 Which characteristic do the energy sources listed below have in common?

coal
moving water
uranium
wind

(1) All are used to produce electrical energy.
(2) All produce substances that harm the environment.
(3) All are renewable.
(4) All are nonrenewable.

☞ GO RIGHT ON TO THE NEXT PAGE.

Figure 1: A page from the New York State General Science Regents Examination.

```
60 In the diagram below, which
  property of the mineral is being
  measured?

  (1) volume
  (2) mass
  (3) hardness
  (4) melting point

               Seen    Rejected Percentage

Characters      104       0       100.00
```

Figure 2: OMNIPAGE output.

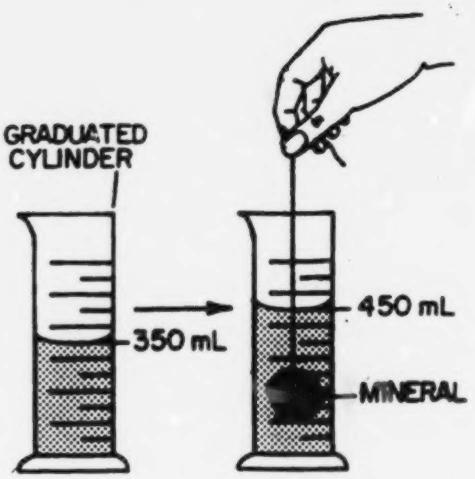

GRADUATED
CYLINDER
350 mL
450 mL
MINERAL

Figure 3: Bitmap of the item graphic produced through scanning.

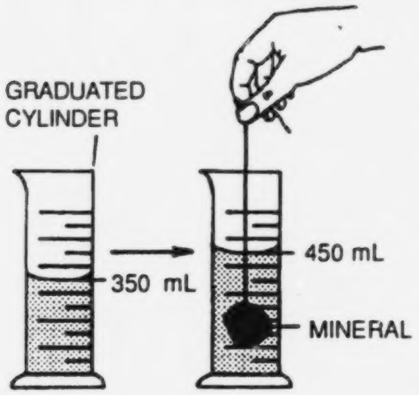
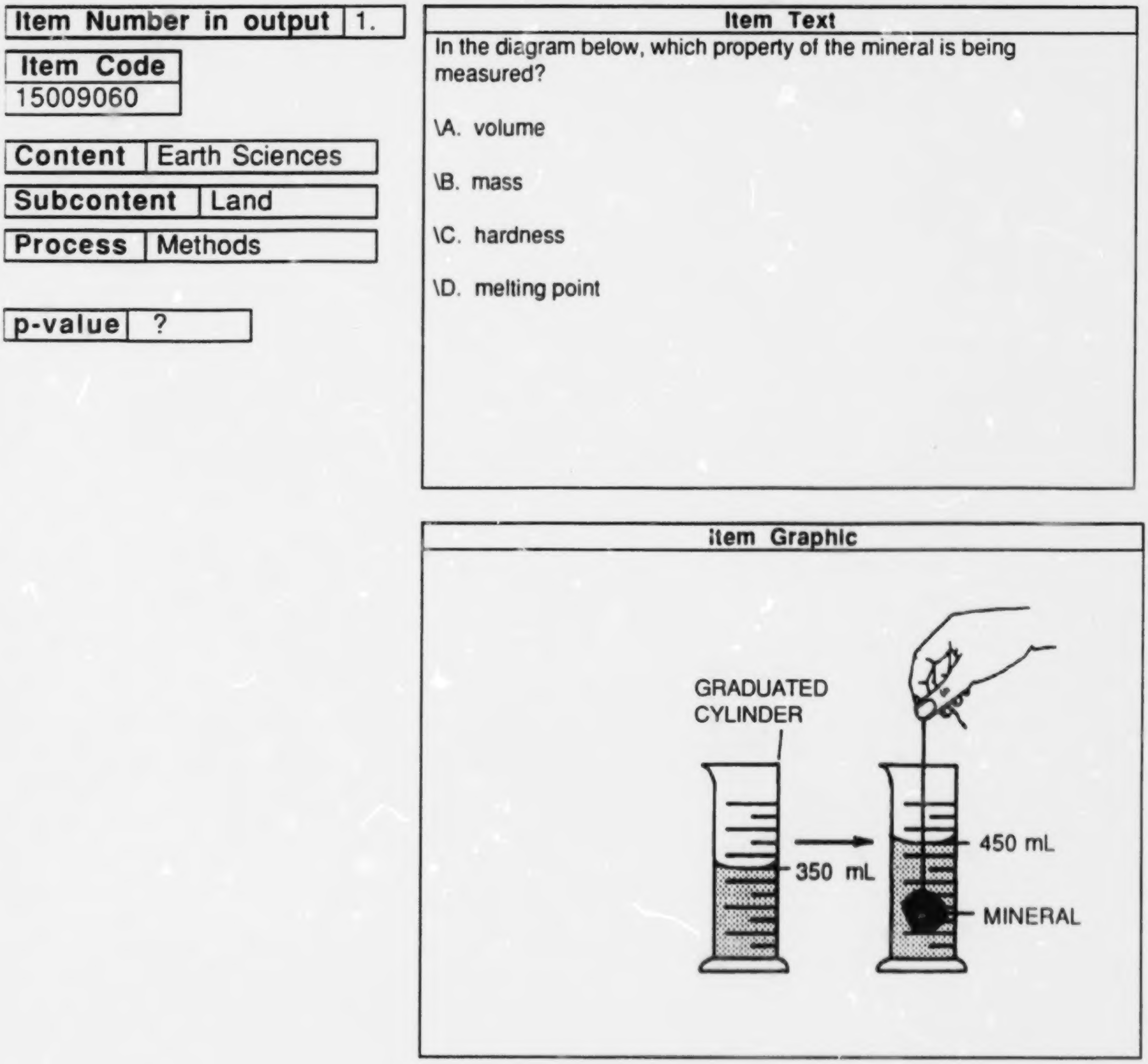

GRADUATED
CYLINDER
350 mL
450 mL
MINERAL

Figure 4: Bitmap after editing in SUPERPAINT.



Item Number in output 1.

Item Code 15009060

Content Earth Sciences

Subcontent Land

Process Methods

p-value ?

Item Text

In the diagram below, which property of the mineral is being measured?

\A. volume

\B. mass

\C. hardness

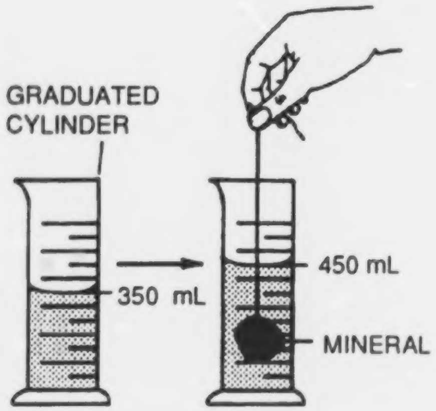
\D. melting point

Item Graphic

GRADUATED CYLINDER
350 mL
450 mL
MINERAL

Figure 5: Screen Display of the item in FILEVISION.

1. In the diagram below, which property of the mineral is being measured?



A. volume

B. mass

C. hardness

D. melting point

2. Fossil fuels most likely were formed over millions of years from the

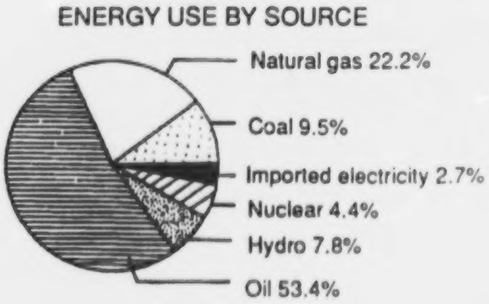
A. rocks found on mountaintops

B. uranium found deep within Earth

C. glaciers which covered Earth

D. remains of dead plants and animals

3. The graph shows the percentage of different sources of energy used in New York State during a recent year. More than half of New York State's energy was obtained from



A. natural gas

B. hydro

C. oil

D. nuclear

4. Nitrites are used to preserve foods and prevent food poisoning. Nitrites can be changed into a cancer-causing substance in the body. Therefore, the use of nitrites to preserve foods provides

A. a benefit, only

B. a risk, only

C. both a benefit and a risk

D. neither a benefit nor a risk

5. Using science knowledge to develop new products is known as

A. prediction

B. measurement

C. observation

D. technology

Figure 6: Camera-ready copy produced with TEXTURES.

1.3.1 Multiple-choice items

1. The item stem must end with a carriage return.
2. There must be a blank line between the item stem and the first item alternative.
3. Each alternative must begin with a `\A.` ,`\B.` etc. (see the item entries in the database or Figure 7).
4. Each item alternative must end with a carriage return followed by a blank line.
5. The graphic for each item must be stored in a separate external file in PICT format. The name and size of the PICT file must be entered in the putpict field in the database.
6. Special formats, such as those required for equations and italics, must be in the TEX language.

1.3.2 Open-ended items

1. The item stem and its parts must end with a carriage return.
2. The item stem and its parts must be separated by blank lines.
3. The graphics for each item must be stored in separate external files in PICT format. The name and size of the PICT files must be entered in putpict statements within the item text. The placement of the putpict statements within the text corresponds to the desired location of the graphics. The `\picture` command must follow each putpict statement.
4. The `\eject` command is used to reserve space for responses to the item parts.
5. Each item part must begin with a `\a.` ,`\b.` etc.
6. Page breaking within an item is controlled with the `\eject` command.
7. Special formats, such as those required for equations and italics, must be in the TEX language.
8. The item must end with the `\enditem\eject` command.

See the item entires in the open-ended database for examples of the formatting procedures.

2 User's guide for the NORC/CRESST science assessment databases

2.1 Proprietary software

Two programs must be purchased to access the databases and to produce camera-ready copy. They are:

1. **FILEVISION IV**

   Marvelin Corporation
   3420 Ocean Park Blvd., Suite 3020
   Santa Monica, CA 90405-3395
   213-450-6813

2. **TEXTURES**

   Blue Sky Research
   534 SW Third Avenue
   Portland, Oregon
   800-622-8398
   503-222-9571

2.2 Installation

1. Install FILEVISION IV and TEXTURES on your hard drive according to the instructions provided with the software.
2. Drag the NORC/CRESST DBASE icons on the NORC/CRESST DATABASE floppy diskette into the FILEVISION folder on your hard disk.
3. Drag the **ToTEXopen** and **ToTEXmultiple** icons on the NORC/CRESST DATABASE floppy diskette into the FILEVISION folder on your hard disk.
4. Drag the **MULTIPLE** and **OPENEND** icons on the NORC/CRESST DATABASE floppy diskette into the TEX formats folder in the TEXTURES folder on your hard disk.
5. Drag the PICT files on the PICT floppy diskettes into the TEXtures folder on your hard disk. Use the **SELECT ALL** command to drag the PICT files as a unit.

The system is now ready to use.

2.3 Contents of the databases

2.3.1 NORC/CRESST multiple-choice database

Figure 7 shows an item entry as it appears in the FILEVISION database. The contents of the item information fields are described below.

1. **Item Number on output.** This field contains the item numbers for the items as they appear in the test booklets for the 12th-grade science assessment study. This field supplies the item numbers for booklet production to the system. It controls the ordering of the items in the booklets.

2. **Item Code.** Item code is an eight digit number which uniquely identifies the item and its source. The index in Appendix A explains the meaning of this code. It shows that the item in Figure 7 is item 27 from the August 1989 New York State Regents examination in Earth Sciences.

3. **Booklet.** Booklet refers to the placement of the item in the booklets of the 12th-grade science assessment instrument. The booklets of this instrument were pitched at four different levels of difficulty: easy (**E**), intermediate (**I**), difficult (**D**), and more difficult (**F**). The item in Figure 7 appears in the intermediate and difficult booklets.

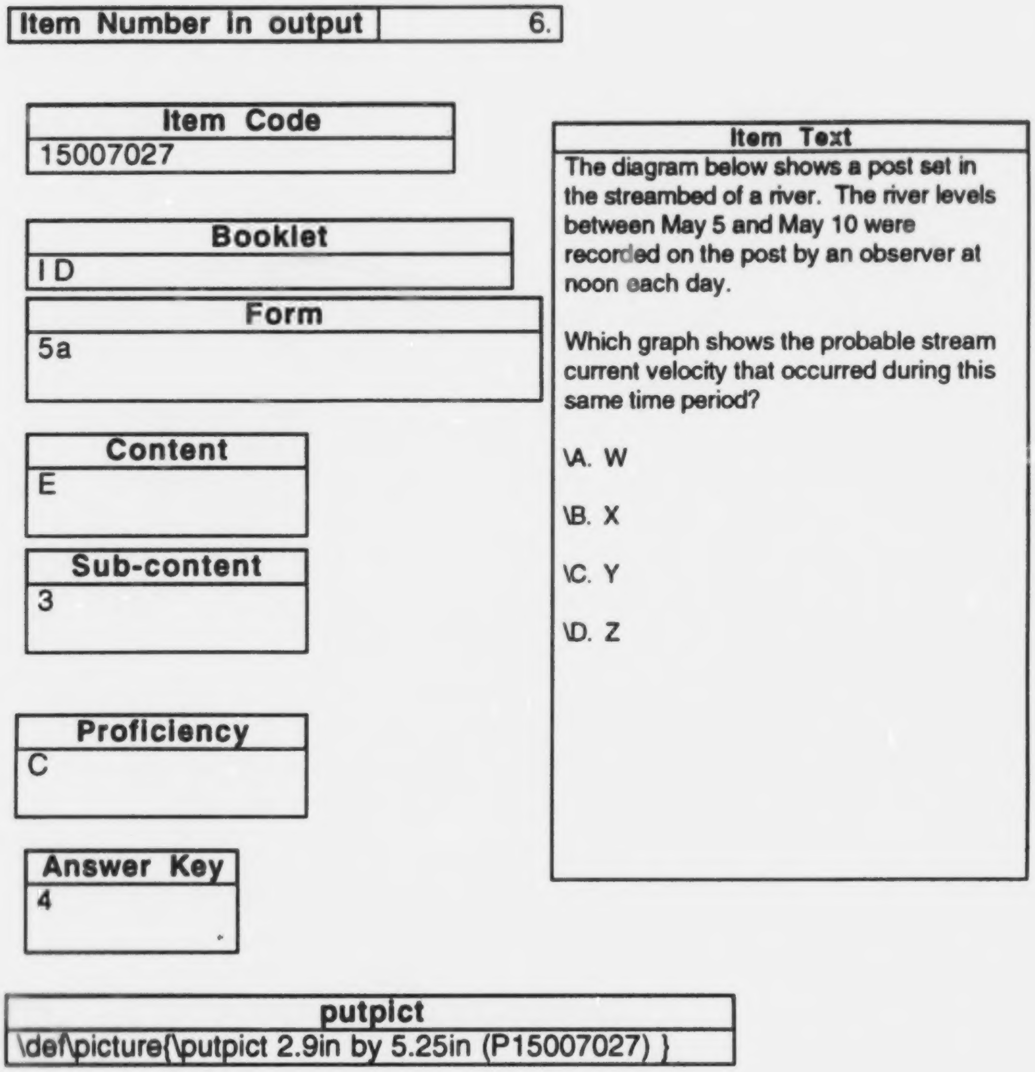
4. **Form.** Form indicates the placement of the items in one of the six forms of the 12th-grade science assessment instrument, namely, 1a, 2a, 3a, 4a, 5a, and 6a. The item in Figure 7 was assigned to Form 5a.

5. **Content.** Content refers to the subject matter classification of the item. **E** is for Earth sciences, **B**, for biology, **C**, for chemistry, and **P**, for physics. The item in Figure 7 is an Earth sciences item.

6. **Sub-content.** Sub-content refers to one of four sub-content classifications within each content area. The codes for sub-content range in value from 1 to 4 and differ in meaning by content area. The item in Figure 7 belongs to the water classification of Earth science items.

   Earth sciences

   1. space
   2. air
   3. water
   4. land



Item Number in output 6.

Item Code
15007027

Booklet
I D

Form
5a

Content
E

Sub-content
3

Proficiency
C

Answer Key
4

Item Text
The diagram below shows a post set in the streambed of a river. The river levels between May 5 and May 10 were recorded on the post by an observer at noon each day.

Which graph shows the probable stream current velocity that occurred during this same time period?

\A. W

\B. X

\C. Y

\D. Z

putpict
```
\def\picture{\putpict 2.9in by 5.25in (P15007027) }
```

Figure 7: An item entry in the multiple-choice database.

Biology

  1. of the cell
  2. of the organism
  3. reproduction and genetics
  4. biological diversity

Chemistry

  1. the atomic model
  2. chemical reactions
  3. quantitative chemistry
  4. states of matter

Physics

  1. mechanics
  2. electricity and magnetism
  3. heat and kinetic theory
  4. waves, optics, and sound

7. **Proficiency**. Proficiency refers to the four process classifications of the items.

   C. understanding of scientific concepts and principles

   F. knowledge of scientific terminology and facts

   M. knowledge of scientific methods and procedures

   P. problem solving

8. **Answer Key**. This field contains the correct answer to the item. The answer to the item in Figure 7 is the fourth alternative or D.

9. **putpict**. The putpict field contains the size and name of the PICT file for the item. The putpict field is blank if the item does not contain graphic information. The PICT file for the item in Figure 7 is called P15007027 and is 2.9 inches wide and 5.25 inches long.

10. **Item Text**. This fields contains the text of the item.

2.3.2 NORC/CRESST open-ended database

The item entries for the open-ended items include fields 1 through 5, and 10 as above.

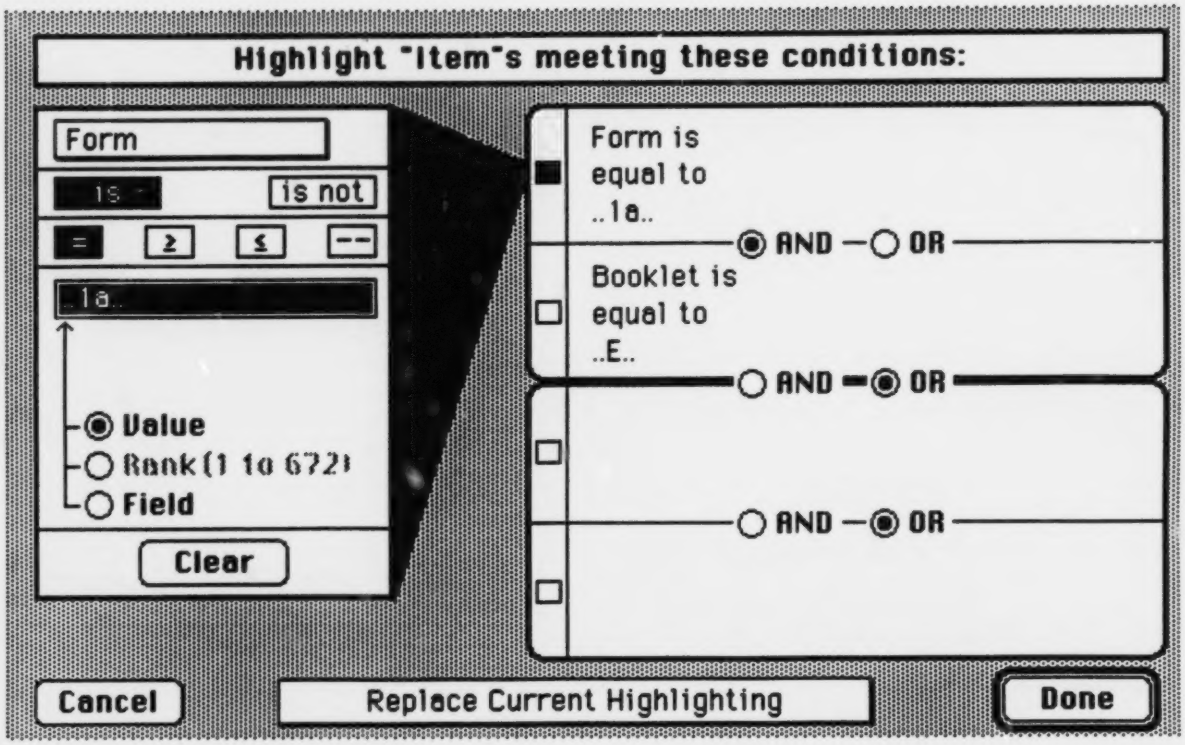
2.4 Accessing the databases

The procedures below access the databases. See the FILEVISION IV manual for a detailed explanation of the commands.

1. Double click the FILEVISION IV icon in the FILEVISION folder.
2. Select **OPEN** from the file menu and open one of the item databases, either NORC/CRESST MULTIPLE-CH. DBASE or NORC/CRESST OPEN-ENDED DBASE.
3. Click **INFO** at the bottom of the window to view the item entries. Each item is a separate entry. Click **NEXT** at the bottom of the window to view the next entry. Notice a number has already been typed in each of the "item number in output" fields. These are the numbers we used for the booklets of the 12th-grade science assessment instrument. If you wish to change the ordering of the items in the booklets, change these numbers.

2.5 Selecting and exporting items for typesetting

1. Return to the drawing page (click **DRAWING** at the bottom of the window).
2. Click the window that appears. **"672 total"** (multiple-choice database) or **"84 total"** (open-ended database) will appear at the bottom of the window.
3. Select **Highlight** from the ACCESS menu. Specify the criteria for item selection (see the FILEVISION manual). When you are finished, click **done** at the bottom of the window. The system is now highlighting items according to your criteria. Figure 8 shows the statements we used to highlight the items in the easy booklet of Form 1a of the science assessment instrument.
4. After the system has highlighted your items, click the window that appears. The number of items you highlighted will appear at the bottom of the page.
5. Select **IMPORT/EXPORT TEXT** from the file menu.
6. Select **EXPORT** from the file menu.
7. Select **LOAD SETUP** from the file menu.
8. OPEN **ToTEXopen** (for open-ended items) or **ToTEXmultiple** for multiple-choice items.
9. Select **START** from the export menu.



Highlight "Item"s meeting these conditions:

Form

■ is ☐ is not

■ = ☐ ≥ ☐ ≤ ☐ --

..1a..

● Value
○ Rank (1 to 672)
○ Field

■ Form is equal to ..1a..

● AND ○ OR

☐ Booklet is equal to ..E..

○ AND ● OR

☐

○ AND ● OR

☐

Clear
Cancel
Replace Current Highlighting
Done

Figure 8: Highlight commands for the easy booklet of Form 1a.

10. Name your file.

11. The file you have just created contains all of the TEXTURES commands needed to produce typeset output. (It should be placed in the TEXTURES folder).

12. To exit Filevision, select **RETURN TO FILEVISION** in the file menu.

13. Click the window that appears. Select **QUIT** from the file menu.

2.6 Producing camera-ready copy

1. Double click the TEXtures icon (in the TeXtures folder).

2. Select **OPEN** from the file menu and open the file you just created.

3. Select **MULTIPLE** (for multiple-choice items) or **OPENEND** (for open-ended items) in the TYPESET menu.

4. Select **TYPESET** in the typeset menu.

5. You will be prompted to type **\end** when the program has finished.

6. You may examine the typeset output by selecting commands in the **VIEW** menu, and, print the camera-ready copy by selecting **PRINT** in the file menu.

The test booklets for the 12th-grade science assessment, found in APPENDIX B, were produced using these procedures.

References

Zimowski, M. F. (1991). *TESTBUILDER: A test construction, scanning, typesetting, and camera-copy utility.* Chicago: National Opinion Research Center, Methodology Research Center.

APPENDIX A

Key to comprehensive index of science assessment materials' codes.

Key to Comprehensive Index of Science Assessment Materials' Codes
as of September 12, 1990

Column Numbers:
1-2: Source of Test
3-5: Booklet or Part of Booklet within Source

01	Alberta Department of Education
01001	Grade 12 Diploma Examination Biology 30 1/89, Part A
01002	Grade 12 Diploma Examination Biology 30 1/89, Part B
01003	Grade 12 Diploma Examination Biology 30 6/89, Part A
01004	Grade 12 Diploma Examination Biology 30 6/89, Part B
01005	Grade 12 Diploma Examination Chemistry 1/89, Part A
01006	Grade 12 Diploma Examination Chemistry 1/89, Part B
01007	Grade 12 Diploma Examination Chemistry 6/89, Part A
01008	Grade 12 Diploma Examination Chemistry 6/89, Part B
01009	Grade 12 Diploma Examination Physics 1/89, Part A
01010	Grade 12 Diploma Examination Physics 1/89, Part B
01011	Grade 12 Diploma Examination Physics 6/89, Part A
01012	Grade 12 Diploma Examination Physics 6/89, Part B
01013	Grade 12 Diploma Examination Mathematics, Part A
01014	Grade 12 Diploma Examination Mathematics, Part B
01015	Grade 12 Diploma Examination Mathematics, Part C
01016	Grade 12 Diploma Examination Biology 30 1/88, Part A
01017	Grade 12 Diploma Examination Biology 30 1/88, Part B
01018	Grade 12 Diploma Examination Biology 30 6/88, Part A
01019	Grade 12 Diploma Examination Biology 30 6/88, Part B
01020	Grade 12 Diploma Examination Biology 30 1/90, Part A
01021	Grade 12 Diploma Examination Biology 30 1/90, Part B
01022	Grade 12 Diploma Examination Biology 30 6/90, Part A
01023	Grade 12 Diploma Examination Biology 30 6/90, Part B
01024	Grade 12 Diploma Examination Chemistry 1/88, Part A
01025	Grade 12 Diploma Examination Chemistry 1/88, Part B
01026	Grade 12 Diploma Examination Chemistry 6/88, Part A
01027	Grade 12 Diploma Examination Chemistry 6/88, Part B
01028	Grade 12 Diploma Examination Chemistry 1/90, Part A
01029	Grade 12 Diploma Examination Chemistry 1/90, Part B
01030	Grade 12 Diploma Examination Chemistry 1/90, Part C
01031	Grade 12 Diploma Examination Chemistry 6/90, Part A
01032	Grade 12 Diploma Examination Chemistry 6/90, Part B
01033	Grade 12 Diploma Examination Chemistry 6/90, Part C
01034	Grade 12 Diploma Examination Physics 1/88, Part A
01035	Grade 12 Diploma Examination Physics 1/88, Part B
01036	Grade 12 Diploma Examination Physics 6/88, Part A
01037	Grade 12 Diploma Examination Physics 6/88, Part B
01038	Grade 12 Diploma Examination Physics 1/90, Part A
01039	Grade 12 Diploma Examination Physics 1/90, Part B
01040	Grade 12 Diploma Examination Physics 6/90, Part A
01041	Grade 12 Diploma Examination Physics 6/90, Part B
02	American Association of Physics Teachers
02001	AAPT/NSTA Introductory Examination
03	American Chemical Society, Division of Chem. Ed., Exam Inst. OK U

03001	ACS/NSTA High School Chemistry 1989
03002	ACS/NSTA High School Chemistry 1990 (Advanced)
03003	ACS/NSTA High School Chemistry 1985
03004	ACS/NSTA High School Chemistry 1987
04	American Geological Institute
04001	AGI/NSTA Earth Science Examination, Version A (same as B)
04002	AGI/NSF Inv the Earth Earth Sci Curr Proj. Unit I, Ch P-6
04003	AGI/NSF Inv the Earth Earth Sci Curr Proj. Unit II, Ch 7-11
04004	AGI/NSF Inv the Earth Earth Sci Curr Proj. Unit II, Ch 12-16
04005	AGI/NSF Inv the Earth Earth Sci Curr Proj. Unit III, Ch 17-21
04006	AGI/NSF Inv the Earth Earth Sci Curr Proj. Unit IV, Ch 22-26
04007	AGI/NSF Inv the Earth Earth Sci Curr Proj. Unit Final, Ch P-26
04008	AGI/NSTA Earth Science Examination, Version B (same as A)
05	Association for Science Education
05001	Biology Practs. Teacher's Guide (2), and Black-line Masters, GE
05002	Biology Practs. Teacher's Guide (2), and Black-line Masters, FO
05003	Biology Practs. Teacher's Guide (2), and Black-line Masters, SE
05004	Biology Practs. Teacher's Guide (2), and Black-line Masters, WA
05005	Biology Practs. Teacher's Guide (2), and Black-line Masters, SO
05006	Biology Practs. Teacher's Guide (2), and Black-line Masters, PO
05007	Biology Practs. Teacher's Guide (2), and Black-line Masters, BR
05008	Biology Practs. Teacher's Guide (2), and Black-line Masters, MO
05009	Biology Practs. Teacher's Guide (2), and Black-line Masters, CI
05010	Biology Practs. Teacher's Guide (2), and Black-line Masters, PH
05011	Biology Practs. Teacher's Guide (2), and Black-line Masters, RE
05012	Biology Practs. Teacher's Guide (2), and Black-line Masters, IN
05013	Biology Practs. Teacher's Guide (2), and Black-line Masters, MI
05014	GCSE Practical Assessment Biology
05015	GCSE Practical Assessment Chemistry
05016	GCSE Practical Assessment Physics
05017	Practical Assessment Biology for GCSE
05018	Practical Assessment Chemistry for GCSE
05019	Practical Assessment for GCSE Balanced Sci. Chemistry GCSE, Ch 1
05020	Practical Assessment for GCSE Balanced Sci. Chemistry GCSE, Ch 2
05021	Practical Assessment for GCSE Balanced Sci. Chemistry GCSE, Ch 3
05022	Practical Assessment for GCSE Balanced Sci. Chemistry GCSE, Ch 4
05023	Practical Assessment for GCSE Balanced Sci. Chemistry GCSE, Ch 5
05024	Practical Assessment for GCSE Balanced Sci. Chemistry GCSE, Ch 6
05025	Practical Assessment for GCSE Balanced Sci. Chemistry GCSE, Ch 7
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05481	Structured Questions for GCSE Chemistry, Test 1, prob b,c
05482	Structured Questions for GCSE Chemistry, Test 1, prob d
05483	Structured Questions for GCSE Chemistry, Test 2, prob a
05484	Structured Questions for GCSE Chemistry, Test 2, prob b
05485	Structured Questions for GCSE Chemistry, Test 3, prob a
05486	Structured Questions for GCSE Chemistry, Test 3, prob b
05487	Structured Questions for GCSE Chemistry, Test 3, prob c
05488	Structured Questions for GCSE Chemistry, Test 3, prob d
05489	Structured Questions for GCSE Chemistry, Test 4, prob a-c
05490	Structured Questions for GCSE Chemistry, Test 4, prob d
05491	Structured Questions for GCSE Chemistry, Test 5, prob a
05492	Structured Questions for GCSE Chemistry, Test 5, prob b
05493	Structured Questions for GCSE Chemistry, Test 5, prob c-e
05494	Structured Questions for GCSE Chemistry, Test 6, prob a,b
05495	Structured Questions for GCSE Chemistry, Test 6, prob c
05496	Structured Questions for GCSE Chemistry, Test 6, prob d
05497	Structured Questions for GCSE Chemistry, Test 6, prob e
05498	Structured Questions for GCSE Chemistry, Test 7, prob a
05499	Structured Questions for GCSE Chemistry, Test 7, prob b
05500	Structured Questions for GCSE Chemistry, Test 7, prob c
05501	Structured Questions for GCSE Chemistry, Test 7, prob d
05502	Structured Questions for GCSE Chemistry, Test 7, prob e
05503	Structured Questions for GCSE Chemistry, Test 7, prob f
05504	Structured Questions for GCSE Chemistry, Test 8
05505	Structured Questions for GCSE Chemistry, Test 9, prob a
05506	Structured Questions for GCSE Chemistry, Test 9, prob b
05507	Structured Questions for GCSE Chemistry, Test 9, prob c
05508	Structured Questions for GCSE Chemistry, Test 9, prob d
05509	Structured Questions for GCSE Chemistry, Test 10, prob a
05510	Structured Questions for GCSE Chemistry, Test 10, prob b
05511	Structured Questions for GCSE Chemistry, Test 10, prob c
05512	Structured Questions for GCSE Chemistry, Test 10, prob d
05513	Structured Questions for GCSE Chemistry, Test 10, prob e-h
05514	Structured Questions for GCSE Chemistry, Test 11
05515	Structured Questions for GCSE Chemistry, Test 12
05516	Structured Questions for GCSE Chemistry, Test 13
05517	Structured Questions for GCSE Chemistry, Test 14
05518	Structured Questions for GCSE Chemistry, Test 15, prob a
05519	Structured Questions for GCSE Chemistry, Test 15, prob b
05520	Structured Questions for GCSE Chemistry, Test 15, prob c
05521	Structured Questions for GCSE Chemistry, Test 15, prob d
05522	Structured Questions for GCSE Chemistry, Test 16
05523	Structured Questions for GCSE Chemistry, Test 17
05524	Structured Questions for GCSE Chemistry, Test 18
05525	Structured Questions for GCSE Chemistry, Test 19, prob a
05526	Structured Questions for GCSE Chemistry, Test 19, prob b
05527	Structured Questions for GCSE Chemistry, Test 19, prob c
05528	Structured Questions for GCSE Chemistry, Test 20
05529	Structured Questions for GCSE Chemistry, Test 21, prob a-d
05530	Structured Questions for GCSE Chemistry, Test 21, prob e
05531	Structured Questions for GCSE Chemistry, Test 21, prob f
05532	Structured Questions for GCSE Chemistry, Test 22, prob a
05533	Structured Questions for GCSE Chemistry, Test 22, prob b
05534	Structured Questions for GCSE Chemistry, Test 22, prob c
05535	Structured Questions for GCSE Chemistry, Test 23, prob a-e

05536	Structured Questions for GCSE Chemistry, Test 23, prob f
05537	Structured Questions for GCSE Chemistry, Test 23, prob g
05538	Structured Questions for GCSE Chemistry, Test 24, prob a-d
05539	Structured Questions for GCSE Chemistry, Test 24, prob e
05540	Structured Questions for GCSE Chemistry, Test 24, prob f
05541	Structured Questions for GCSE Chemistry, Test 25
05542	Structured Questions for GCSE Chemistry, Test 26, prob a,b
05543	Structured Questions for GCSE Chemistry, Test 26, prob c
05544	Structured Questions for GCSE Chemistry, Test 26, prob d
05545	Structured Questions for GCSE Chemistry, Test 27
05546	Structured Questions for GCSE Chemistry, Test 28, prob a
05547	Structured Questions for GCSE Chemistry, Test 28, prob b
05548	Structured Questions for GCSE Chemistry, Test 28, prob c,d
05549	Structured Questions for GCSE Chemistry, Test 29
05550	Structured Questions for GCSE Chemistry, Test 30, prob a
05551	Structured Questions for GCSE Chemistry, Test 30, prob b
05552	Structured Questions for GCSE Chemistry, Test 30, prob c
05553	Structured Questions for GCSE Chemistry, Test 30, prob d
05554	Structured Questions for GCSE Chemistry, Test 31, prob a,b
05555	Structured Questions for GCSE Chemistry, Test 31, prob c
05556	Structured Questions for GCSE Chemistry, Test 31, prob d
05557	Structured Questions for GCSE Chemistry, Test 32, prob a
05558	Structured Questions for GCSE Chemistry, Test 32, prob b,c
05559	Structured Questions for GCSE Chemistry, Test 32, prob d
05560	Structured Questions for GCSE Chemistry, Test 32, prob e
05561	Structured Questions for GCSE Chemistry, Test 33, prob a
05562	Structured Questions for GCSE Chemistry, Test 33, prob b
05563	Structured Questions for GCSE Chemistry, Test 33, prob c
05564	Structured Questions for GCSE Chemistry, Test 33, prob d
05565	Structured Questions for GCSE Chemistry, Test 34, prob a-c
05566	Structured Questions for GCSE Chemistry, Test 34, prob d
05567	Structured Questions for GCSE Chemistry, Test 34, prob e
05568	Structured Questions for GCSE Chemistry, Test 35, prob a,b
05569	Structured Questions for GCSE Chemistry, Test 35, prob c
05570	Structured Questions for GCSE Chemistry, Test 35, prob d-g
05571	Structured Questions for GCSE Chemistry, Test 36, prob a
05572	Structured Questions for GCSE Chemistry, Test 36, prob b-f
05573	Structured Questions for GCSE Chemistry, Test 37, prob a,b
05574	Structured Questions for GCSE Chemistry, Test 37, prob c
05575	Structured Questions for GCSE Chemistry, Test 37, prob d
05576	Structured Questions for GCSE Chemistry, Test 38, prob a
05577	Structured Questions for GCSE Chemistry, Test 38, prob b
05578	Structured Questions for GCSE Chemistry, Test 38, prob c-f
05579	Structured Questions for GCSE Chemistry, Test 39, prob a
05580	Structured Questions for GCSE Chemistry, Test 39, prob b
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05583	Structured Questions for GCSE Chemistry, Test 40, prob a-c
05584	Structured Questions for GCSE Chemistry, Test 40, prob d
05585	Structured Questions for GCSE Chemistry, Test 40, prob e
05586	Structured Questions for GCSE Chemistry, Test 40, prob f-i
05587	Structured Questions for GCSE Chemistry, Test 41
05588	Structured Questions for GCSE Chemistry, Test 42, prob a,b
05589	Structured Questions for GCSE Chemistry, Test 42, prob c
05590	Structured Questions for GCSE Chemistry, Test 42, prob d,e

05591	Structured Questions for GCSE Chemistry, Test 42, prob f
05592	Structured Questions for GCSE Chemistry, Test 42, prob g,h
05593	Structured Questions for GCSE Chemistry, Test 43, prob a
05594	Structured Questions for GCSE Chemistry, Test 43, prob b
05595	Structured Questions for GCSE Chemistry, Test 43, prob c
05596	Structured Questions for GCSE Chemistry, Test 43, prob d
05597	Structured Questions for GCSE Chemistry, Test 44, prob a
05598	Structured Questions for GCSE Chemistry, Test 44, prob b
05599	Structured Questions for GCSE Chemistry, Test 44, prob c
05600	Structured Questions for GCSE Chemistry, Test 44, prob d
05601	Structured Questions for GCSE Chemistry, Test 45
05602	Structured Questions for GCSE Chemistry, Test 46
05603	Structured Questions for GCSE Chemistry, Test 47, prob a
05604	Structured Questions for GCSE Chemistry, Test 47, prob b
05605	Structured Questions for GCSE Chemistry, Test 47, prob c
05606	Structured Questions for GCSE Chemistry, Test 48, prob a
05607	Structured Questions for GCSE Chemistry, Test 48, prob b
05608	Structured Questions for GCSE Chemistry, Test 48, prob c,d
05609	Structured Questions for GCSE Chemistry, Test 48, prob e
05610	Structured Questions for GCSE Chemistry, Test 48, prob f
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05614	Structured Questions for GCSE Chemistry, Test 50, prob a
05615	Structured Questions for GCSE Chemistry, Test 50, prob b
05616	Structured Questions for GCSE Chemistry, Test 50, prob c
05617	Structured Questions for GCSE Chemistry, Test 50, prob d
05618	Structured Questions for GCSE Chemistry, Test 51
05619	Structured Questions for GCSE Chemistry, Test 52, prob a
05620	Structured Questions for GCSE Chemistry, Test 52, prob b
05621	Structured Questions for GCSE Chemistry, Test 52, prob c
05622	Structured Questions for GCSE Chemistry, Test 52, prob d
05623	Structured Questions for GCSE Chemistry, Test 52, prob e,f
05624	Structured Questions for GCSE Chemistry, Test 53, prob a-c
05625	Structured Questions for GCSE Chemistry, Test 53, prob d
05626	Structured Questions for GCSE Chemistry, Test 53, prob e-g
05627	Structured Questions for GCSE Chemistry, Test 54, prob a
05628	Structured Questions for GCSE Chemistry, Test 54, prob b
05629	Structured Questions for GCSE Chemistry, Test 54, prob c
05630	Structured Questions for GCSE Chemistry, Test 54, prob d
05631	Structured Questions for GCSE Chemistry, Test 55, prob a
05632	Structured Questions for GCSE Chemistry, Test 55, prob b
05633	Structured Questions for GCSE Chemistry, Test 55, prob c
05634	Structured Questions for GCSE Chemistry, Test 55, prob d
05635	Structured Questions for GCSE Chemistry, Test 55, prob e
05636	Structured Questions for GCSE Chemistry, Test 56, prob a-c
05637	Structured Questions for GCSE Chemistry, Test 56, prob d
05638	Structured Questions for GCSE Chemistry, Test 56, prob e
05639	Structured Questions for GCSE Chemistry, Test 56, prob f
05640	Structured Questions for GCSE Chemistry, Test 56, prob g,h
05641	Structured Questions for GCSE Chemistry, Test 57, prob a
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05643	Structured Questions for GCSE Chemistry, Test 57, prob d
05644	Structured Questions for GCSE Chemistry, Test 57, prob e-g
05645	Structured Questions for GCSE Chemistry, Test 58, prob a-c

05646	Structured Questions for GCSE Chemistry, Test 58, prob d
05647	Structured Questions for GCSE Chemistry, Test 58, prob e
05648	Structured Questions for GCSE Chemistry, Test 58, prob f
05649	Structured Questions for GCSE Chemistry, Test 59, prob a
05650	Structured Questions for GCSE Chemistry, Test 59, prob b
05651	Structured Questions for GCSE Chemistry, Test 59, prob c
05652	Structured Questions for GCSE Chemistry, Test 59, prob d
05653	Structured Questions for GCSE Chemistry, Test 59, prob e
05654	Structured Questions for GCSE Chemistry, Test 60, prob a
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05656	Structured Questions for GCSE Chemistry, Test 60, prob c
05657	Structured Questions for GCSE Chemistry, Test 61, prob a-d
05658	Structured Questions for GCSE Chemistry, Test 61, prob e
05659	Structured Questions for GCSE Chemistry, Test 61, prob f
05660	Structured Questions for GCSE Chemistry, Test 62, prob a
05661	Structured Questions for GCSE Chemistry, Test 62, prob b
05662	Structured Questions for GCSE Chemistry, Test 62, prob c
05663	Structured Questions for GCSE Chemistry, Test 62, prob d
05664	Structured Questions for GCSE Chemistry, Test 62, prob e
05665	Structured Questions for GCSE Chemistry, Test 63, prob a
05666	Structured Questions for GCSE Chemistry, Test 63, prob b
05667	Structured Questions for GCSE Chemistry, Test 63, prob c
05668	Structured Questions for GCSE Chemistry, Test 64, prob a-d
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05670	Structured Questions for GCSE Chemistry, Test 64, prob f
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05675	Structured Questions for GCSE Chemistry, Test 65, prob e
05676	Structured Questions for GCSE Chemistry, Test 66
05677	Structured Questions for GCSE Chemistry, Test 67, prob a-c
05678	Structured Questions for GCSE Chemistry, Test 67, prob d
05679	Structured Questions for GCSE Chemistry, Test 67, prob e
05680	Structured Questions for GCSE Chemistry, Test 67, prob f,g
05681	Structured Questions for GCSE Chemistry, Test 68, prob a
05682	Structured Questions for GCSE Chemistry, Test 68, prob b
05683	Structured Questions for GCSE Chemistry, Test 68, prob c
05684	Structured Questions for GCSE Chemistry, Test 68, prob d
05685	Structured Questions for GCSE Chemistry, Test 68, prob e
05686	Structured Questions for GCSE Chemistry, Test 69, prob a
05687	Structured Questions for GCSE Chemistry, Test 69, prob b
05688	Structured Questions for GCSE Chemistry, Test 69, prob c
05689	Structured Questions for GCSE Chemistry, Test 70, prob a
05690	Structured Questions for GCSE Chemistry, Test 70, prob b
05691	Structured Questions for GCSE Chemistry, Test 70, prob c
05692	Structured Questions for GCSE Chemistry, Test 70, prob d
05693	Structured Questions for GCSE Chemistry, Test 70, prob e
05694	Structured Questions for GCSE Chemistry, Test 71, prob a
05695	Structured Questions for GCSE Chemistry, Test 71, prob b
05696	Structured Questions for GCSE Chemistry, Test 71, prob c
05697	Structured Questions for GCSE Chemistry, Test 72, prob a,b
05698	Structured Questions for GCSE Chemistry, Test 72, prob c
05699	Structured Questions for GCSE Chemistry, Test 72, prob d
05700	Structured Questions for GCSE Chemistry, Test 72, prob e

05701	Structured Questions for GCSE Chemistry, Test 72, prob f
05702	Structured Questions for GCSE Chemistry, Test 73, prob a
05703	Structured Questions for GCSE Chemistry, Test 73, prob b
05704	Structured Questions for GCSE Chemistry, Test 73, prob c
05705	Structured Questions for GCSE Chemistry, Test 73, prob d
05706	Structured Questions for GCSE Chemistry, Test 73, prob e
05707	Structured Questions for GCSE Chemistry, Test 74, prob a-d
05708	Structured Questions for GCSE Chemistry, Test 74, prob e
05709	Structured Questions for GCSE Chemistry, Test 74, prob f
05710	Structured Questions for GCSE Chemistry, Test 74, prob g
05711	Structured Questions for GCSE Chemistry, Test 75, prob a
05712	Structured Questions for GCSE Chemistry, Test 75, prob b
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05716	Structured Questions for GCSE Chemistry, Test 76, prob a-d
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05719	Structured Questions for GCSE Chemistry, Test 76, prob g
05720	Structured Questions for GCSE Chemistry, Test 77, prob a-c
05721	Structured Questions for GCSE Chemistry, Test 77, prob d
05722	Structured Questions for GCSE Chemistry, Test 77, prob e
05723	Structured Questions for GCSE Chemistry, Test 77, prob f
05724	Structured Questions for GCSE Chemistry, Test 77, prob g
05725	Structured Questions for GCSE Chemistry, Test 77, prob h
05726	Structured Questions for GCSE Chemistry, Test 78, prob a
05727	Structured Questions for GCSE Chemistry, Test 78, prob b
05728	Structured Questions for GCSE Chemistry, Test 78, prob c
05729	Structured Questions for GCSE Chemistry, Test 78, prob d
05730	Structured Questions for GCSE Chemistry, Test 78, prob e
05731	Structured Questions for GCSE Chemistry, Test 79, prob a
05732	Structured Questions for GCSE Chemistry, Test 79, prob b
05733	Structured Questions for GCSE Chemistry, Test 79, prob c
05734	Structured Questions for GCSE Chemistry, Test 79, prob d,e
05735	Structured Questions for GCSE Chemistry, Test 80, prob a,b
05736	Structured Questions for GCSE Chemistry, Test 80, prob c
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05751	Data Handling Skills for GCSE Science, B1, 4
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05793	Data Handling Skills for GCSE Science, C2, 6
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05795	Data Handling Skills for GCSE Science, C3, 1
05796	Data Handling Skills for GCSE Science, C3, 2
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05808	Data Handling Skills for GCSE Science, C5, 2
05809	Data Handling Skills for GCSE Science, C5, 3
05810	Data Handling Skills for GCSE Science, C5, 4

05811	Data Handling Skills for GCSE Science, C5, 5
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05813	Data Handling Skills for GCSE Science, C5, 7
05814	Data Handling Skills for GCSE Science, C5, 8
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05816	Data Handling Skills for GCSE Science, C6, 2
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05823	Data Handling Skills for GCSE Science, P1, 5
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05835	Data Handling Skills for GCSE Science, P4, 1-5
05836	Data Handling Skills for GCSE Science, P4, 6
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05866	Data Handling Skills for GCSE Science, G5, 4
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05999	Practical Assessments in Chemistry at GCSE Level, Exp 16

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06	Michigan State Board of Education
06001	MEAP Grade 5 Science
06002	MEAP Grade 8 Science
06003	MEAP Grade 11 Science
07	Minnesota Department of Education
07001	MN Educational Assessment Program, Science Grade 11, Package 1
07002	MN Educational Assessment Program, Science Grade 11, Package 2
07003	MN Educational Assessment Program, Science Grade 11, Package 3
04	MN Educational Assessment Program, Science Grade 11, Package 4
08	National Association of Biology Teachers
08001	NABT/NSTA High School Biology Examination
09	Ontario Ministry of Education
09001	Ontario Assessment Instrument Pool Chemistry I ??
09002	Ontario Assessment Instrument Pool Chemistry I Chapter 9
09003	Ontario Assessment Instrument Pool Chemistry I Chapter 10
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09034	Ontario Assessment Instrument Pool Geography Canada, Test C1C
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09053	Ontario Assessment Instrument Pool Geography Canada, Test S3H
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09064	Ontario Assessment Instrument Pool Geography N. America, Test N1G
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09066	Ontario Assessment Instrument Pool Geography N. America, Test N1I
09067	Ontario Assessment Instrument Pool Geography N. America, Test N1J
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09080 Ontario Assessment Instrument Pool Geography N. America, Test S1G
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09083 Ontario Assessment Instrument Pool Geography N. America, Test S1J
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09086 Ontario Assessment Instrument Pool Geography S. Cont., Test S2A
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09089 Ontario Assessment Instrument Pool Geography S. Cont., Test S2D
09090 Ontario Assessment Instrument Pool Geography S. Cont., Test S2E
09091 Ontario Assessment Instrument Pool Geography S. Cont., Test S2F
09092 Ontario Assessment Instrument Pool Geography S. Cont., Test S2G
09093 Ontario Assessment Instrument Pool Geography S. Cont., Test S2H
09094 Ontario Assessment Instrument Pool Geography S. Cont., Test S2I
09095 Ontario Assessment Instrument Pool Geography S. Cont., Test S2J
09096 Ontario Assessment Instrument Pool Physics I, M
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09099 Ontario Assessment Instrument Pool Physics I, K-MPV
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09101 Ontario Assessment Instrument Pool Physics I, D-CFG
09102 Ontario Assessment Instrument Pool Physics I, D-ICM
09103 Ontario Assessment Instrument Pool Physics I, D-WKE
09104 Ontario Assessment Instrument Pool Physics I, D-GPE
09105 Ontario Assessment Instrument Pool Physics I, L-GO
09106 Ontario Assessment Instrument Pool Physics I, L-PML
09107 Ontario Assessment Instrument Pool Physics I, L-CBW
09108 Ontario Assessment Instrument Pool Physics I, L-IPW
09109 Ontario Assessment Instrument Pool Physics I, L-WML
09110 Ontario Assessment Instrument Pool Physics I, EM-EFC
09111 Ontario Assessment Instrument Pool Physics I, EM-EFP
09112 Ontario Assessment Instrument Pool Physics I, EM-CEE
09113 Ontario Assessment Instrument Pool Physics I, EM-ES
09114 Ontario Assessment Instrument Pool Physics I, WPD-P
09115 Ontario Assessment Instrument Pool Physics I, A-RM
09116 Ontario Assessment Instrument Pool Physics I, A-EL
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09122 Ontario Assessment Instrument Pool Physics II, K-MSL-33
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09125 Ontario Assessment Instrument Pool Physics II, D-FNL
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09127 Ontario Assessment Instrument Pool Physics II, D-CFG
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09129 Ontario Assessment Instrument Pool Physics II, D-ICM
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09133 Ontario Assessment Instrument Pool Physics II, D-GPE-15
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09141 Ontario Assessment Instrument Pool Physics II, L-WML
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09143 Ontario Assessment Instrument Pool Physics II, EM-EFP
09144 Ontario Assessment Instrument Pool Physics II, EM-EFC
09145 Ontario Assessment Instrument Pool Physics II, EM-EFC-23
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09159 Ontario Assessment Instrument Pool Physics II, E-E-6
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09161 Ontario Assessment Instrument Pool Physics II, E-A
09162 Ontario Assessment Instrument Pool Physics II, BE-P-N
09163 Ontario Assessment Instrument Pool Physics II, GO-ST
09164 Ontario Assessment Instrument Pool Physics II, GO-ST-4
09165 Ontario Assessment Instrument Pool Physics II, GO-R
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09168 Ontario Assessment Instrument Pool Physics II, GO-RFRA-11
09169 Ontario Assessment Instrument Pool Physics II, GO-OI
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09172 Ontario Assessment Instrument Pool Physics II, C-C-M
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09174 Ontario Assessment Instrument Pool Physics II, FL-R
09175 Ontario Assessment Instrument Pool Physics II, FL-R-3
09176 Ontario Assessment Instrument Pool Physics II, FL-M
09177 Ontario Assessment Instrument Pool Physics II, FL-M-3
09178 Ontario Assessment Instrument Pool Physics II, T-T
09179 Ontario Assessment Instrument Pool Physics II, T-H
09180 Ontario Assessment Instrument Pool Physics II, T-C
09181 Ontario Assessment Instrument Pool Physics II, T-C-5
09182 Ontario Assessment Instrument Pool Physics II, ST-M
09183 Ontario Assessment Instrument Pool Physics II, R-R

09184	Ontario Assessment Instrument Pool Physics II, R-R-14
09185	Ontario Assessment Instrument Pool Physics II, R-RE
09186	Ontario Assessment Instrument Pool Physics II, ES-S
09187	Ontario Assessment Instrument Pool Physics II, ES-S-3
09188	Ontario Assessment Instrument Pool Physics II, HA-U
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09190	Ontario Assessment Instrument Pool Physics II, HA-N
09191	Ontario Assessment Instrument Pool Physics III, M
09192	Ontario Assessment Instrument Pool Physics III, F
09193	Ontario Assessment Instrument Pool Physics III, K-MSL
09194	Ontario Assessment Instrument Pool Physics III, K-MPV
09195	Ontario Assessment Instrument Pool Physics III, D-FNL
09196	Ontario Assessment Instrument Pool Physics III, D-CFG
09197	Ontario Assessment Instrument Pool Physics III, D-ICM
09198	Ontario Assessment Instrument Pool Physics III, D-WKE
09199	Ontario Assessment Instrument Pool Physics III, D-GPE

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09200	Ontario Assessment Instrument Pool Physics III, L-CBW
09201	Ontario Assessment Instrument Pool Physics III, L-WML
09202	Ontario Assessment Instrument Pool Physics III, EM-EFP
09203	Ontario Assessment Instrument Pool Physics III, EM-CEE
09204	Ontario Assessment Instrument Pool Physics III, WPD-P
09205	Ontario Assessment Instrument Pool Physics III, WPD-MW
09206	Ontario Assessment Instrument Pool Physics III, A-EL
09207	Ontario Assessment Instrument Pool Physics III, S-M
09208	Ontario Assessment Instrument Pool Physics III, E-A
09209	Ontario Assessment Instrument Pool Physics III, GO-R
09210	Ontario Assessment Instrument Pool Physics III, GO-RFRA
09211	Ontario Assessment Instrument Pool Physics III, C-S
09212	Ontario Assessment Instrument Pool Physics III, C-CV
09213	Ontario Assessment Instrument Pool Physics III, FL-R
09214	Ontario Assessment Instrument Pool Physics III, ES-C
09215	Ontario Assessment Instrument Pool Physics IV, Skill
09216	Ontario Assessment Instrument Pool Physics IV, Lab
09217	Ontario Assessment Instrument Pool Physics V, M
09218	Ontario Assessment Instrument Pool Physics V, M-5
09219	Ontario Assessment Instrument Pool Physics V, F
09220	Ontario Assessment Instrument Pool Physics V, F-9
09221	Ontario Assessment Instrument Pool Physics V, K-MSL
09222	Ontario Assessment Instrument Pool Physics V, K-MSL-36
09223	Ontario Assessment Instrument Pool Physics V, K-MPV
09224	Ontario Assessment Instrument Pool Physics V, K-MPV-31
09225	Ontario Assessment Instrument Pool Physics V, D-FNL
09226	Ontario Assessment Instrument Pool Physics V, D-FNL-14
09227	Ontario Assessment Instrument Pool Physics V, D-CFG
09228	Ontario Assessment Instrument Pool Physics V, D-CFG-21
09229	Ontario Assessment Instrument Pool Physics V, D-ICM
09230	Ontario Assessment Instrument Pool Physics V, D-ICM-21
09231	Ontario Assessment Instrument Pool Physics V, D-WKE
09232	Ontario Assessment Instrument Pool Physics V, D-WKE-22
09233	Ontario Assessment Instrument Pool Physics V, D-GPE
09234	Ontario Assessment Instrument Pool Physics V, D-GPE-20
09235	Ontario Assessment Instrument Pool Physics V, L-GO
09236	Ontario Assessment Instrument Pool Physics V, L-PML
09237	Ontario Assessment Instrument Pool Physics V, L-PML-4

09238 Ontario Assessment Instrument Pool Physics V, L-CBW
09239 Ontario Assessment Instrument Pool Physics V, L-IPW
09240 Ontario Assessment Instrument Pool Physics V, L-WML
09241 Ontario Assessment Instrument Pool Physics V, L-WML-21
09242 Ontario Assessment Instrument Pool Physics V, E-EFC
09243 Ontario Assessment Instrument Pool Physics V, EM-EFP
09244 Ontario Assessment Instrument Pool Physics V, EM-CEE
09245 Ontario Assessment Instrument Pool Physics V, EM-ES
09246 Ontario Assessment Instrument Pool Physics V, WPD-P
09247 Ontario Assessment Instrument Pool Physics V, WPD-MW
09248 Ontario Assessment Instrument Pool Physics V, WPD-MW-5
09249 Ontario Assessment Instrument Pool Physics V, A-RM
09250 Ontario Assessment Instrument Pool Physics V, A-EL
09251 Ontario Assessment Instrument Pool Physics V, GO-RFRA
09252 Ontario Assessment Instrument Pool Physics V, GO-RFRA-5
09253 Ontario Assessment Instrument Pool Physics V, R-R
09254 Ontario Assessment Instrument Pool Physics V, HA-K
09255 Ontario Assessment Instrument Pool Physics V, HA-K-2
09256 Ontario Assessment Instrument Pool Physics V, HA-G
09257 Ontario Assessment Instrument Pool Physics V, HA-N
09258 Ontario Assessment Instrument Pool Draft OAC Biology, Unit 1
09259 Ontario Assessment Instrument Pool Draft OAC Biology, Unit 2
09260 Ontario Assessment Instrument Pool Draft OAC Biology, Unit 3
09261 Ontario Assessment Instrument Pool Draft OAC Biology, Unit 4
09262 Ontario Assessment Instrument Pool Draft OAC Biology, Unit 5
09263 Ontario Assessment Instrument Pool Draft OAC Biology, Unit 6
09264 Ontario Assessment Instrument Pool Draft OAC Biology, Unit 7
09265 Ontario Assessment Instrument Pool Physics III, L-GO
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10 Queen's University at Kingston, Ontario
10001 Chemistry Laboratory Achievement Test
11 Science Teachers' Association of Victoria
11001 Physics Group 1, Victorian Certificate of Education, TT 1988
11002 Physics Year 11, Trial Test 1988
11003 Victorian Certificate of Education, TT 1988, Biology, Section A
11004 Victorian Certificate of Education, TT 1988, Biology, Sections B&C
11005 Victorian Certificate of Education, TT 1989, Biology, Section A
11006 Victorian Certificate of Education, TT 1989, Biology, Sections B&C
11007 Victorian Certificate of Education, TT 1988, Chemistry, Section A
11008 Victorian Certificate of Education, TT 1988, Chemistry, Section B
11009 Victorian Certificate of Education, TT 1989, Chemistry, Section A
11010 Victorian Certificate of Education, TT 1989, Chemistry, Section B
12 State University of New York at Buffalo
12001 Introductory Physical Science Laboratory Test No. 1
13 Pinchas Tamir
13001 Inquiry-Oriented Performance Test Assessment Inventory
14 Technion Institute of Technology
14001 Rockets and Space Flight, Experiment 1
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14029	Rockets and Space Flight, page 56
15	University of New York at Albany, State Education Department
15001	New York General Chemistry
15002	Regents High School Examination Biology, Mon, Jun. 1989
15003	Regents High School Examination Biology, Thu, Aug. 1989
15004	Regents High School Examination Chemistry, Tue, Jun. 1989
15005	Regents High School Examination Chemistry, Thu, Aug. 1989
15006	Regents High School Examination Earth Sciences, Mon, Jun. 1989
15007	Regents High School Examination Earth Sciences, Thu, Aug. 1989
15008	Regents High School Examination Physics, Thu, Jun. 1989
15009	Regents High School Examination Science, Tue, Jan. 1989
15010	Regents High School Examination Science, Wed, Jun. 1989
15011	Regents High School Examination Science, Wed, Jun. 1988
15012	Regents High School Examination Science, Fri, Jan. 1990
15013	Regents High School Examination Biology, Tue, Jun. 1990
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15015	Regents High School Examination Earth Sciences, Tue, Jun. 1990
15016	Regents High School Examination Physics, Fri, Jun. 1990
15017	Regents High School Examination Science, Thu, Jun. 1990
15018	Regents High School Examination Biology, Thu, Aug. 1990
15019	Regents High School Examination Chemistry, Thu, Aug. 1990
15020	Regents High School Examination Earth Sciences, Thu, Aug. 1990
16	Virginia Department of Education
16001	Standards of Learning Biology Grade 10 10.1 I
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16066	Standards of Learning Earth Science Grade 9 9.18I
16067	Standards of Learning Earth Science Grade 9 9.18II

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16093	Standards of Learning Life Science Grade 7 7.21
16094	Standards of Learning Physics Grade 12 12.1
16095	Standards of Learning Physics Grade 12 12.2
16096	Standards of Learning Physics Grade 12 12.3
16097	Standards of Learning Physics Grade 12 12.4
16098	Standards of Learning Physics Grade 12 12.5
16099	Standards of Learning Physics Grade 12 12.6
16100	Standards of Learning Physics Grade 12 12.7
16101	Standards of Learning Physics Grade 12 12.8&9
16102	Standards of Learning Physics Grade 12 12.10
16103	Standards of Learning Physics Grade 12 12.11
16104	Standards of Learning Physics Grade 12 12.12
16105	Standards of Learning Physics Grade 12 12.13I
16106	Standards of Learning Physics Grade 12 12.13II
16107	Standards of Learning Physics Grade 12 12.14
16108	Standards of Learning Physics Grade 12 12.15
16109	Standards of Learning Physics Grade 12 12.16
16110	Standards of Learning Physics Grade 12 12.17A
16111	Standards of Learning Physics Grade 12 12.17B
16112	Standards of Learning Physics Grade 12 12.18
16113	Standards of Learning Physical Science Grade 8 8.1
16114	Standards of Learning Physical Science Grade 8 8.2
16115	Standards of Learning Physical Science Grade 8 8.3A
16116	Standards of Learning Physical Science Grade 8 8.3B
16117	Standards of Learning Physical Science Grade 8 8.4
16118	Standards of Learning Physical Science Grade 8 8.5I
16119	Standards of Learning Physical Science Grade 8 8.5II
16120	Standards of Learning Physical Science Grade 8 8.6&7
16121	Standards of Learning Physical Science Grade 8 8.8
16122	Standards of Learning Physical Science Grade 8 8.9I

16123	Standards of Learning Physical Science Grade 8 8.9II
16124	Standards of Learning Physical Science Grade 8 8.10A
16125	Standards of Learning Physical Science Grade 8 8.10B
16126	Standards of Learning Physical Science Grade 8 8.10C
16127	Standards of Learning Physical Science Grade 8 8.11
16128	Standards of Learning Physical Science Grade 8 8.12
16129	Standards of Learning Physical Science Grade 8 8.13
16130	Standards of Learning Physical Science Grade 8 8.14
16131	Standards of Learning Physical Science Grade 8 8.15
16132	Standards of Learning Physical Science Grade 8 8.16
16133	Standards of Learning Physical Science Grade 8 8.17
16134	Standards of Learning Physical Science Grade 8 8.18
16135	Standards of Learning Chemistry Grade 11 11.12II
17	International Educational Assessment
17001	International Science Study Advanced Science, Math Test
17002	International Science Study Advanced Science, Questionnaire
17003	International Science Study Advanced Science, Opinionnaire
17004	International Science Study Advanced Science, Science Learning
17005	International Science Study Advanced Science, Word Knowledge
17006	International Science Study First Year Biology, Booklet 1
17007	International Science Study First Year Biology, Book 2, Math Test
17008	International Science Study First Year Biology, Book 2, Question.
17009	International Science Study First Year Biology, Book 2, Opinionn.
17010	International Science Study First Year Biology, Book 2, Sci. Learn
17011	International Science Study First Year Biology, Book 2, Word Know.
17012	International Science Study First Yr Chemistry, Book 2, Math Test
17013	International Science Study First Yr Chemistry, Book 2, Question.
17014	International Science Study First Yr Chemistry, Book 2, Opinionn.
17015	International Science Study First Yr Chemistry, Book 2, Sci. Learn
17016	International Science Study First Yr Chemistry, Book 2, Word Know.
17017	International Science Study First Yr Chemistry, Trial Test 1
17018	International Science Study Grade 12 General, Booklet 1
17019	International Science Study Grade 12 General, Booklet 2
17020	International Science Study Grade 12 Physics
17021	International Science Study Second Year Biology
17022	International Science Study Second Year Chemistry
17023	International Science Study Second Year Physics
17024	International Science Study Grade 9 General A
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17026	International Science Study Grade 9 General C
17027	International Science Study Grade 9 General Core
17028	International Science Study Grade 9 General D
17029	International Science Study Test 3E
17030	International Science Study Grade 9A (lab)
17031	International Science Study Grade 9B (lab)
18	California Assessment Program
18001	CAP Grade 12 Science Field Test in Biology
18002	CAP Grade 12 Science Field Test in Earth Science
18003	CAP Grade 12 Science Field Test in Physical Science
18004	Golden State Examination Biology Test, Form A, ms quest.
18005	Golden State Examination Biology Test, Form A, oe quest.
18006	Golden State Examination Biology Test, Form B, ms quest.
18007	Golden State Examination Biology Test, Form B, oe quest.
18008	Golden State Examination Biology Test, Form C, ms quest.
18009	Golden State Examination Biology Test, Form C, oe quest.

18010	[Golden State Examination] Biology Performance Task #1
18011	[Golden State Examination] Biology Performance Task #2
18012	[Golden State Examination] Biology Performance Task #3
18013	[Golden State Examination] Biology Performance Task #4
18014	[Golden State Examination] Biology Performance Task #5
18015	[Golden State Examination] Biology Performance Task #6
18016	[Golden State Examination] Chemistry F T, Pt 1, Form 1
18017	[Golden State Examination] Chemistry F T, Pt 1, Form 2
18018	[Golden State Examination] Chemistry F T, Pt 1, Form 3
18019	[Golden State Examination] Chemistry F T, Pt 1, Form 4
18020	[Golden State Examination] Chemistry F T, Pt 1, Form 5
18021	[Golden State Examination] Chemistry F T, Pt 2, Form A
18022	[Golden State Examination] Chemistry F T, Pt 2, Form B
18023	[Golden State Examination] Chemistry F T, Pt 2, Form C
18024	[Golden State Examination] Chemistry F T, Pt 2, Form D
18025	[Golden State Examination] Chemistry F T, Pt 2, Form E
18026	[Golden State Examination Chemistry F T] Perf Task I
18027	[Golden State Examination Chemistry F T] Perf Task II
18028	[Golden State Examination Chemistry F T] Perf Task III
18029	[Golden State Examination Chemistry F T] Perf Task IV
18030	[Golden State Examination Chemistry F T] Perf Task V
18031	[Golden State Examination Chemistry F T] Perf Task VI
18032	[Golden State Examination Chemistry F T] Perf Task VII
19	Association for Science Education (continued)
19001	Practical Assessments in Chemistry at GCSE Lvl (cont.), Exp 17
19002	Practical Assessments in Chemistry at GCSE Lvl (cont.), Exp 18
19003	Practical Assessments in Chemistry at GCSE Lvl (cont.), Exp 19
19004	Practical Assessments in Chemistry at GCSE Lvl (cont.), Exp 20
19005	Practical Biology A Guide to Teacher Assessment, 4.1
19006	Practical Biology A Guide to Teacher Assessment, 4.2
19007	Practical Biology A Guide to Teacher Assessment, 4.3
19008	Practical Biology A Guide to Teacher Assessment, 5.1
19009	Practical Biology A Guide to Teacher Assessment, 5.2
19010	Practical Biology A Guide to Teacher Assessment, 5.3
19011	Practical Biology A Guide to Teacher Assessment, 6.1
19012	Practical Biology A Guide to Teacher Assessment, 6.2
19013	Practical Biology A Guide to Teacher Assessment, 6.3
19014	Practical Biology A Guide to Teacher Assessment, 7.1
19015	Practical Biology A Guide to Teacher Assessment, 7.2
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19020	Practical Biology A Guide to Teacher Assessment, 8.3
19021	Practical Biology A Guide to Teacher Assessment, 8.4
19022	Practical Biology A Guide to Teacher Assessment, 10.1
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19024	Practical Biology A Guide to Teacher Assessment, 10.3
19025	Practical Biology A Guide to Teacher Assessment, 10.4
19026	Practical Biology A Guide to Teacher Assessment, 10.5
19027	Practical Biology A Guide to Teacher Assessment, 10.6
19028	Practical Biology A Guide to Teacher Assessment, 10.7
19029	Practical Biology A Guide to Teacher Assessment, 10.8
19030	Practical Biology A Guide to Teacher Assessment, 10.9
19031	Practical Biology A Guide to Teacher Assessment, 10.10

19032	Practical Biology A Guide to Teacher Assessment, 10.11
19033	Practical Biology A Guide to Teacher Assessment, 10.12
19034	Practical Biology A Guide to Teacher Assessment, 10.13
19035	Practical Biology A Guide to Teacher Assessment, 10.14
19036	Techniques for Assessing Process Skills..., Item Set 1
19037	Techniques for Assessing Process Skills..., Item Set 2
19038	Techniques for Assessing Process Skills..., Item Set 3
19039	Techniques for Assessing Process Skills..., Item Set 4
19040	Techniques for Assessing Process Skills..., Item Set 5
19041	Techniques for Assessing Process Skills..., Item Set 6
19042	Techniques for Assessing Process Skills..., Item Set 7
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19044	Techniques for Assessing Process Skills..., Item Set 9
19045	Techniques for Assessing Process Skills..., Item Set 10
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19048	Techniques for Assessing Process Skills..., Item Set 14
19049	Techniques for Assessing Process Skills..., Item Set 15
19050	Techniques for Assessing Process Skills..., SP1.1
19051	Techniques for Assessing Process Skills..., SP1.2
19052	Techniques for Assessing Process Skills..., SP1.3
19053	Techniques for Assessing Process Skills..., SP1.4
19054	Techniques for Assessing Process Skills..., SP1.5
19055	Techniques for Assessing Process Skills..., SP1.6
19056	Techniques for Assessing Process Skills..., SP2.1
19057	Techniques for Assessing Process Skills..., SP2.2
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19060	Techniques for Assessing Process Skills..., SP2.5
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19062	Techniques for Assessing Process Skills..., SP2.7
19063	Techniques for Assessing Process Skills..., SP3.1
19064	Techniques for Assessing Process Skills..., SP3.2
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19066	Techniques for Assessing Process Skills..., SP3.4
19067	Techniques for Assessing Process Skills..., SP3.5
19068	Techniques for Assessing Process Skills..., SP3.6
19069	Techniques for Assessing Process Skills..., SP3.7
19070	Techniques for Assessing Process Skills..., SP4.1
19071	Techniques for Assessing Process Skills..., SP4.2
19072	Techniques for Assessing Process Skills..., SP4.3
19073	Techniques for Assessing Process Skills..., SP4.4
19074	Techniques for Assessing Process Skills..., SP4.5
19075	Techniques for Assessing Process Skills..., SP4.6
19076	Techniques for Assessing Process Skills..., SP4.7
19077	Techniques for Assessing Process Skills..., SP4.8
19078	Techniques for Assessing Process Skills..., SP4.9
19079	Techniques for Assessing Process Skills..., SP4.10
19080	Techniques for Assessing Process Skills..., SP4.11
19081	Techniques for Assessing Process Skills..., SP4.12
19082	Techniques for Assessing Process Skills..., SP4.13
19083	Techniques for Assessing Process Skills..., SP4.14
19084	Techniques for Assessing Process Skills..., SP4.15
19085	Techniques for Assessing Process Skills..., SP4.16
19086	Course Work Assess. in GCSE Bio. A Pract..., Exp. 1

19087	Course Work Assess. in GCSE Bio. A Pract..., Exp. 2
19088	Course Work Assess. in GCSE Bio. A Pract..., Exp. 3
19089	Course Work Assess. in GCSE Bio. A Pract..., Exp. 4
19090	Course Work Assess. in GCSE Bio. A Pract..., Exp. 5
19091	Course Work Assess. in GCSE Bio. A Pract..., Exp. 6
19092	Course Work Assess. in GCSE Bio. A Pract..., Exp. 7
19093	Course Work Assess. in GCSE Bio. A Pract..., Exp. 8
19094	Course Work Assess. in GCSE Bio. A Pract..., Exp. 9
19095	Course Work Assess. in GCSE Bio. A Pract..., Exp. 10
19096	Course Work Assess. in GCSE Bio. A Pract..., Exp. 11
19097	Course Work Assess. in GCSE Bio. A Pract..., Exp. 12
19098	Course Work Assess. in GCSE Bio. A Pract..., Exp. 13
19099	Course Work Assess. in GCSE Bio. A Pract..., Exp. 14
19100	Course Work Assess. in GCSE Bio. A Pract..., Exp. 15
19001	Course Work Assess. in GCSE Bio. A Pract..., Exp. 16
19002	Course Work Assess. in GCSE Bio. A Pract..., Exp. 17
19003	Course Work Assess. in GCSE Bio. A Pract..., Exp. 18
19004	Course Work Assess. in GCSE Bio. A Pract..., Exp. 19
19005	Course Work Assess. in GCSE Bio. A Pract..., Exp. 20
19006	Course Work Assess. in GCSE Bio. A Pract..., Exp. 21
19007	Course Work Assess. in GCSE Bio. A Pract..., Exp. 22
19008	Course Work Assess. in GCSE Bio. A Pract..., Exp. 23
19009	Course Work Assess. in GCSE Bio. A Pract..., Exp. 24
19010	Course Work Assess. in GCSE Bio. A Pract..., Exp. 25
19011	Course Work Assess. in GCSE Bio. A Pract..., Exp. 26
19012	Course Work Assess. in GCSE Bio. A Pract..., Exp. 27
19013	Course Work Assess. in GCSE Bio. A Pract..., Exp. 28
19014	Course Work Assess. in GCSE Bio. A Pract..., Exp. 29
19015	Course Work Assess. in GCSE Bio. A Pract..., Exp. 30
19016	Course Work Assess. in GCSE Bio. A Pract..., Exp. 31
20	Instructional Objectives Exchange (On loan from R. Doran)
20001	Biology, 10-12, Objective 1
20002	Biology, 10-12, Objective 2
20003	Biology, 10-12, Objective 3
20004	Biology, 10-12, Objective 4
20005	Biology, 10-12, Objective 5
20006	Biology, 10-12, Objective 6
20007	Biology, 10-12, Objective 7
20008	Biology, 10-12, Objective 8
20009	Biology, 10-12, Objective 9
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20011	Biology, 10-12, Objective 11
20012	Biology, 10-12, Objective 12
20013	Biology, 10-12, Objective 13
20014	Biology, 10-12, Objective 14
20015	Life Sciences K-6, General Principle A
20016	Life Sciences K-6, General Principle B
20017	Life Sciences K-6, General Principle C
20018	Life Sciences K-6, General Principle D
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20020	Life Sciences K-6, General Principle F
20021	Life Sciences K-6, General Principle G
20022	Life Sciences K-6, General Principle H
20023	Life Sciences K-6, General Principle I
20024	Life Sciences K-6, General Principle J

20025	Life Sciences K-6, General Principle K
20026	Life Sciences K-6, General Principle L
20027	Life Sciences K-6, General Principle M
20028	Life Sciences K-6, General Principle N
20029	Life Sciences K-6, General Principle O
20030	Life Sciences K-6, General Principle P
20031	Life Sciences K-6, General Principle Q
20032	Life Sciences K-6, General Principle R
20033	Life Sciences K-6, General Principle S
20034	Life Sciences K-6, General Principle T
20035	Life Sciences K-6, General Principle U
20036	Physics 10-12 (Cite by Objective Number)
21	Rand McNally & Company
21001	Interaction of Earth & Time Achievement Test 2
22	Dr. R. Darrell Bock, University of Chicago/NORC
22001	Biology Open-ended Items
22002	Chemistry Open-ended Items
22003	Earth Sciences Open-ended Items
22004	Physics Open-ended Items
22005	Biology Multiple-choice Items
22006	Chemistry Multiple-choice Items
22007	Earth Sciences Multiple-choice Items
22008	Physics Multiple-choice Items
23	John Wiley & Sons, Incorporated
23001	Biology Teachers' Handbook, Invitations (do not indicate by 23001###, indicate "Invitations" by page number.)
23002	Biology Teachers' Handbook, p. 458 A
23003	Biology Teachers' Handbook, p. 458 B
23004	Biology Teachers' Handbook, p. 459 Relat. Betw. Bod. of Knowl.
23005	Biology Teachers' Handbook, p. 459 A1
23006	Biology Teachers' Handbook, p. 459 A2
23007	Biology Teachers' Handbook, p. 461 A3
23008	Biology Teachers' Handbook, p. 462 A4
23009	Biology Teachers' Handbook, p. 463 A5
23010	Biology Teachers' Handbook, p. 463+ A6
23011	Biology Teachers' Handbook, p. 466 B1a
23012	Biology Teachers' Handbook, p. 466 B1b
23013	Biology Teachers' Handbook, p. 466 B2
23014	Biology Teachers' Handbook, p. 467 B3
23015	Biology Teachers' Handbook, p. 468 B4
23016	Biology Teachers' Handbook, p. 469 B5
23017	Biology Teachers' Handbook, p. 472 B6
23018	Biology Teachers' Handbook, p. 474+ A
23019	Biology Teachers' Handbook, p. 476 B,C,D
23020	Biology Teachers' Handbook, p. 477 E
23021	Biology Teachers' Handbook, p. 478 F
23022	Biology Teachers' Handbook, p. 479 G
23023	Biology Teachers' Handbook, p. 479 H
23024	Biology Teachers' Handbook, p. 480 I
23025	Biology Teachers' Handbook, p. 481 J
23026	Biology Teachers' Handbook, p. 486
24	Von Steuben High School, Chicago, IL
24001	Henry Rosenbaum, Biology

6-8: Item Number (as recorded in Source Material), except for OAIP Biology items and all CAP items, for which 6-8 refers to page number. Also note that source 18003 has items from 600-1000+; therefore, pages greater than 999 will be treated as 1000-000; ie: 1015=015, 1020=020, etc. Tentative policy: Open-ended items from SOL tests encompassing more than one single item number, shall be referred to by page number.

APPENDIX B

Test booklets from the 12th-grade science assessment study

Form 1
Easy

1. The BEST explanation of the Northern Lights is that they are produced by

☐ electrostatic induction.
☐ reflection from the polar ice caps.
☐ rotation of the Earth's magnetic field.
☐ energetic particles in the Earth's upper atmosphere.

2. If an astronaut in his space suit could jump 1 meter high on Earth, how high could he jump on the Moon?

☐ 1/3 meter
☐ 2/3 meter
☐ 1 meter
☐ 2 meters
☐ 6 meters

3. Even though animals consume oxygen, the amount of oxygen in the atmosphere remains relatively constant because oxygen is given off by

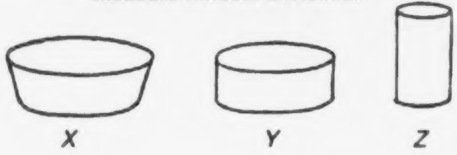
☐ rocks.
☐ animals.
☐ the ocean.
☐ plants.

4. The sun's energy is most apparent at which stage in the water cycle?

☐ transpiration
☐ evaporation
☐ rain
☐ surface flow

5. How would readings of water depth in the containers below, made immediately after a rain, at the same time and location, vary?

Containers Placed Outside to Measure Amount of Rainfall



☐ *Y* and *Z* would show the same reading; *X* would be lower.
☐ *X* and *Y* would show the same reading; *Z* would be higher.
☐ *X*, *Y*, and *Z* would have different readings; *X* would be highest and *Z* lowest.
☐ More information is needed to answer the question.

6. If you were looking for gold in a stream, where would it be found?

☐ at the lowest level of most of the material under the water
☐ at the top surface of the material under the water
☐ flowing with the water
☐ dissolved in the water
☐ all of these places

1

7. The minerals found in a sample of rock can best be identified by their

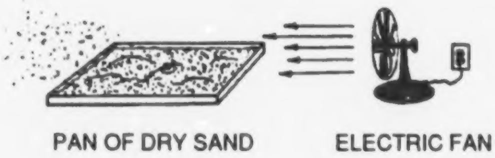
☐ ages.

☐ amounts and sizes.

☐ physical and chemical properties.

☐ locations in the rock.

8. What natural process on Earth's crust is represented by the model below?



☐ evaporation

☐ erosion

☐ fossil formation

☐ chemical change

9. Starches are broken down into simple sugars by the action of

☐ enzymes.

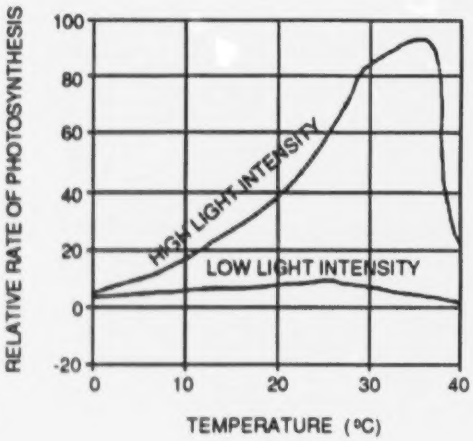
☐ minerals.

☐ hormones.

☐ water.

10. Base your answer to the question below on the graph below which relates the rate of photosynthesis in a geranium plant to varying conditions of temperature and light intensity.

At a low light intensity, an increase in temperature will



☐ greatly slow down the rate of photosynthesis.

☐ greatly speed up the rate of photosynthesis.

☐ have no effect on the rate of photosynthesis.

☐ have little effect on the rate of photosynthesis.

11. Arteries have thicker and more elastic walls than veins. This is because the blood in arteries

☐ contains more food.

☐ contains more oxygen.

☐ is under more pressure.

☐ has to go to all parts of the body.

☐ is thicker.

12. Whether a person has a tendency to be overweight is determined by

☐ amount of exercise.

☐ amount of energy the body requires when resting.

☐ number of calories consumed per day.

☐ efficiency of the digestive system.

☐ all of the above.

13. Some seeds germinate (start to grow) best in the dark, others in the light, while others germinate equally well in the dark or the light. A girl wanted to find out by means of an experiment to which group a certain kind of seed belonged. She should put some of the seeds on damp newspaper and

☐ keep them in a warm place in the dark.

☐ keep one batch in the light and another in the dark.

☐ keep them in a warm place in the light.

☐ put some on dry newspaper and keep them in the light.

☐ put some on dry newspaper and keep them in the dark.

14. The results below are from experiments which were designed to find how long it took for newborn babies of different mammals to double in weight.

What do the results of these experiments suggest?

Mammal	Time in days to double the weight of the newborn baby	Percentage protein in the milk of the mother
human	180	1.6
horse	60	2.0
cow	47	3.5
pig	18	5.9
sheep	10	6.5
dog	8	7.1
rabbit	6	10.4

☐ The larger the mammal, the greater the protein concentration in the milk.

☐ The smaller the mammal, the greater the protein concentration in the milk.

☐ The greater the protein concentration in the mammal's milk, the slower the newborn baby will double its weight.

☐ The greater the protein concentration in the mammal's milk, the faster the newborn baby will double its weight.

☐ There appears to be no relationship between protein concentration in mammal's milk and time taken for a newborn baby to double its birth weight.

15. Reconstructing the way of life of an extinct organism is partly based on comparing its fossils to

☐ inorganic sediments.

☐ living organisms.

☐ minerals of the same age.

☐ traces of decomposers.

16. Here are four organisms that make up a food chain:

I. Snail

II. Cabbage

III. Small bird

IV. Owl

Which of the following lists is a correct food chain with the producer listed first?

☐ I, II, III and IV

☐ I, III, II and IV

☐ II, III, I and IV

☐ II, I, III and IV

☐ IV, III, II and I

17. The mass of an atom depends mainly on the number of

☐ protons only.

☐ neutrons only.

☐ protons plus neutrons.

☐ protons plus electrons.

18. An ion of the element Al (aluminum) carries a charge of 3+. Which choice in the following table best describes this ion?

	ATOMIC No.	MASS No.	No. OF PROTONS	No. OF NEUTRONS	No. OF ELECTRONS
A	10	13	13	10	13
B	13	13	10	14	13
C	13	27	13	14	10
D	13	27	13	14	13

☐ A

☐ B

☐ C

☐ D

19. A catalyst in a chemical system may do all of the following EXCEPT

☐ speed up the reaction.

☐ slow down the reaction.

☐ make a reaction economically important.

☐ change the temperature used for the reaction.

☐ change the amounts of products and reactants present at equilibrium.

20. Tearing a piece of paper into small pieces is considered a physical change rather than a chemical change because

☐ no new substances are formed.

☐ no energy is wasted.

☐ very little heat is given off.

☐ paper contains no chemicals.

21. In each of five experiments, two objects were weighed four times each. Which experiment gives the strongest evidence that object I weighs more than object II?

		Object I	Object II
A	Experiment A	80 lb.	70 lb.
		81 lb.	69 lb.
		80 lb.	71 lb.
		82 lb.	70 lb.
B	Experiment B	69 lb.	81 lb.
		71 lb.	82 lb.
		70 lb.	80 lb.
		70 lb.	80 lb.
C	Experiment C	70 lb.	80 lb.
		75 lb.	75 lb.
		77 lb.	73 lb.
		80 lb.	70 lb.
D	Experiment D	80 lb.	70 lb.
		75 lb.	75 lb.
		73 lb.	77 lb.
		70 lb.	80 lb.
E	Experiment E	80 lb.	77 lb.
		79 lb.	76 lb.
		78 lb.	75 lb.
		77 lb.	74 lb.

☐ A

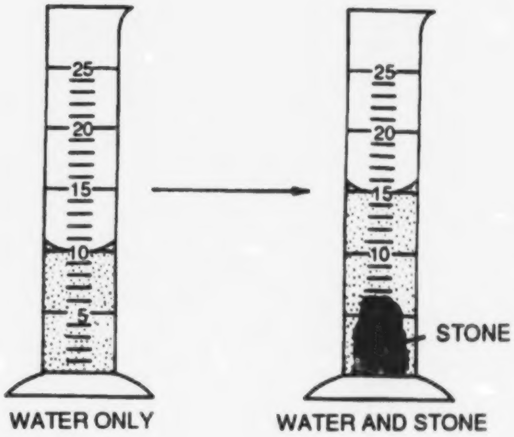
☐ B

☐ C

☐ D

☐ E

22. A stone is placed in a graduated cylinder containing 10 milliliters of water, as shown in the diagram. What is the volume of this stone?



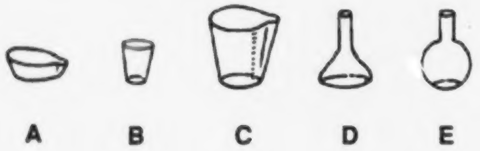
☐ 5 mL

☐ 10 mL

☐ 15 mL

☐ 16 mL

23. Which of the following represents an evaporation dish?



☐ A
☐ B
☐ C
☐ D
☐ E

24. The property of gases that accounts for pressure is

☐ the space between molecules.
☐ the density of the gas.
☐ the motion of the gas molecules.
☐ the identity of the gas.

25. Assuming no friction, the amount of work done to a lever is always

☐ less than the amount of work done by the lever.
☐ greater than the amount of work done by the lever.
☐ the same as the amount of work done by the lever.

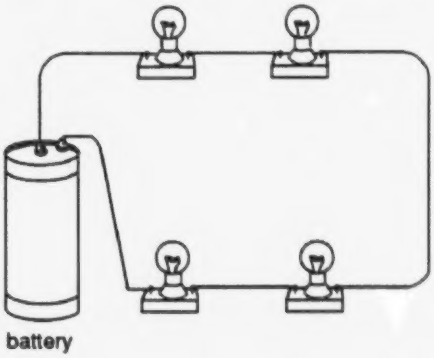
26. A boat travels at 18 km/h directly toward the opposite bank of a 40m wide stream in which there is a steady current running at 10 km/h. How far is the boat carried downstream before reaching the opposite shore if the boat stays pointing directly across the stream?

☐ 22 m
☐ 7.0 m
☐ 4.5 m
☐ 72 m
☐ 50 m

27. An electric current in a copper wire involves mainly the movement of

☐ copper atoms.
☐ copper molecules.
☐ electrons.
☐ neutrons.

28. The graph below represents a(n)



☐ series circuit.
☐ parallel circuit.
☐ wet cell.
☐ electroscope.

29. Temperature is a measurement of the

- ☐ average kinetic energy of molecules.
- ☐ size of molecules.
- ☐ space between molecules.
- ☐ shape of molecules.

30. A 50 W light bulb operating for 20 s uses the same amount of energy as a 100 W bulb operating for

- ☐ 2.0 s
- ☐ 5.0 s
- ☐ 10 s
- ☐ 20 s
- ☐ 40 s

31. The table shows the results of an experiment in which the minimum wavelength of the X-rays produced by an X-ray machine is related to the voltage of the machine. The independent (manipulated) and dependent (responding) variables respectively are

Potential Difference (kV)	Minimum Wavelength (nm)
10	0.13
12	0.10
15	0.083
18	0.069
21	0.059

- ☐ wavelength and frequency.
- ☐ potential difference and voltage.
- ☐ wavelength and potential difference.
- ☐ potential difference and wavelength.

32. Bill is a long distance from Ann. He sees Ann hit a nail into a board before he hears the sound of the nail being hit. Which statement best explains Bill's observation?

- ☐ A gentle wind blowing from Bill toward Ann slowed the speed of the sound waves.
- ☐ Peoples eyes are in front of their ears; therefore, light reaches the eyes before sound reaches the ears.
- ☐ The speed of light is faster than the speed of sound.
- ☐ The speed of light is slower than the speed of sound.

Form 1
Intermediate

1. The BEST explanation of the Northern Lights is that they are produced by

☐ electrostatic induction.
☐ reflection from the polar ice caps.
☐ rotation of the Earth's magnetic field.
☐ energetic particles in the Earth's upper atmosphere.

2. If the Earth rotated from east to west, instead of west to east, the North Star would appear to

☐ rise in the south.
☐ remain almost stationary.
☐ set in the east.
☐ rise in the east.

3. Plants take nitrogen from the air. One way it is returned is by

☐ decaying plants and dead animals.
☐ the health of animals.
☐ plants giving it off during photosynthesis.
☐ water evaporating.

4. Warm air will rise through cooler air because warm air

☐ has its molecules closer together.
☐ is less dense.
☐ has a lower percentage of lightweight atoms.
☐ is less likely to form a convection current.

5. For the size of a river delta to give us any indication about how long it has been forming, we must assume that the rate of depositing sediment

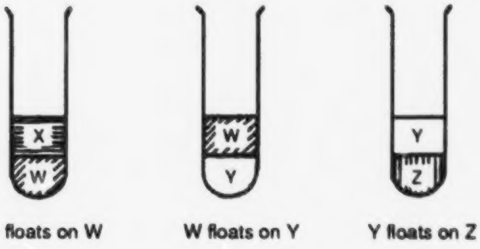
☐ is the same now as in the past.

☐ was faster in the past.

☐ was slower in the past.

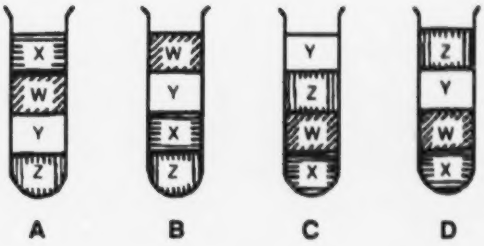
☐ is unimportant, as long as you know what it is now.

6. Four liquids, W, X, Y, and Z, do not mix with each other when they are poured into test tubes as shown below in (1). The four liquids are poured into one test tube. Which diagram in (2) shows how the liquids will float in the test tube?



X floats on W W floats on Y Y floats on Z

(1)



(2)

☐ A

☐ B

☐ C

☐ D

7. The minerals found in a sample of rock can best be identified by their

☐ ages.

☐ amounts and sizes.

☐ physical and chemical properties.

☐ locations in the rock.

8. How do the effects of physical (mechanical) weathering differ most fundamentally from those of chemical weathering?

☐ Physical weathering changes the size of particles, whereas chemical weathering does not.

☐ Chemical weathering changes the size of particles, whereas physical weathering does not.

☐ Physical weathering changes the composition of particles, whereas chemical weathering does not.

☐ Chemical weathering changes the composition of particles, whereas physical weathering does not.

9. Terrestrial plants obtain the carbon dioxide they require for photosynthesis mostly from the

☐ soil water.

☐ soil gases.

☐ carbonates in the soil.

☐ the atmosphere.

☐ breakdown of stored starch.

10. Saliva was mixed with a starch suspension and divided into five parts. Each part was kept at a different temperature for 15 minutes. The amount of sugar produced at each temperature was measured.

Which of the following conclusions can be drawn from the experimental data below?

Temperature (^{0}C)	0	20	40	60	80
Relative amount of sugar	10	60	90	30	2

☐ Enzyme activity stops at 0°C.

☐ A very high temperature reduces enzyme activity.

☐ Enzyme activity is unaffected by temperature.

☐ The optimum temperature for the reaction is 20°C.

☐ The higher the temperature the faster the rate of change of starch.

11. A MAJOR function of the kidney is the

☐ deamination of amino acids.

☐ chemical breakdown of urea.

☐ removal of glucose from the blood.

☐ removal of nitrogenous wastes from the blood.

12. Some doctors are now prescribing medications such as insulin and flu vaccines in the form of nasal sprays and nose drops. The advantages of using these methods include increased convenience and faster absorption. The reason for the rapid absorption of nasal sprays is that the nasal cavity has

☐ a close proximity to the control centers of the brain.

☐ many cilia that will transport the medication quickly.

☐ many odor receptors that absorb the medication.

☐ a high concentration of capillaries in its lining.

13. Which of the following best describes the information given on a gene map?

☐ the relative number of genes on the members of a pair of homologous chromosomes

☐ the potential for gene mutation

☐ the sequence and relative distance between the genes on a chromosome

☐ the position of abnormal genes

☐ the length of the chromosome in genetic units

14. The results below are from experiments which were designed to find how long it took for newborn babies of different mammals to double in weight.

What do the results of these experiments suggest?

Mammal	Time in days to double the weight of the newborn baby	Percentage protein in the milk of the mother
human	180	1.6
horse	60	2.0
cow	47	3.5
pig	18	5.9
sheep	10	6.5
dog	8	7.1
rabbit	6	10.4

☐ The larger the mammal, the greater the protein concentration in the milk.

☐ The smaller the mammal, the greater the protein concentration in the milk.

☐ The greater the protein concentration in the mammal's milk, the slower the newborn baby will double its weight.

☐ The greater the protein concentration in the mammal's milk, the faster the newborn baby will double its weight.

☐ There appears to be no relationship between protein concentration in mammal's milk and time taken for a newborn baby to double its birth weight.

15. Reconstructing the way of life of an extinct organism is partly based on comparing its fossils to

☐ inorganic sediments.

☐ living organisms.

☐ minerals of the same age.

☐ traces of decomposers.

16. The fossil record shows that dinosaurs existed in great numbers and in many different forms. From a scientific viewpoint, the most reasonable conclusion is that

☐ this was the reason for their respective extinctions.

☐ the many different species occupied many different ecological niches.

☐ they never became very specialized.

☐ they were the direct ancestors of animals that occupy the various niches today.

☐ they were resistant to diseases.

17. Atoms with the same atomic number but different atomic mass are called

☐ isomers.

☐ isosceles.

☐ isobars.

☐ isotopes.

18. Atoms of element A have 2 electrons in their highest occupied energy level. Atoms of element B have 7 electrons in their highest occupied energy level. A possible formula of the compound formed between A and B is

☐ AB_3

☐ A_2B

☐ AB_2

☐ A_7B_2

19. The products of any neutralization reaction are

☐ carbon dioxide and water.

☐ an acid and a base.

☐ a salt and water.

☐ sodium chloride and water.

20. A certain reaction does not take place in the dark but proceeds explosively as soon as it is exposed to light. Which of the following is an explanation of this observation?

☐ Light provides the energy which is released as heat in the explosion.

☐ Light initiates the reaction which then proceeds very rapidly.

☐ Light acts as a catalyst, being regenerated during the explosion.

☐ The total reaction is endothermic and light initiates it by supplying much more than the required energy.

21. For a calorimetric experiment to determine the molar heat of combustion for a fuel, the information that would not be required is the

☐ time required to burn the fuel.

☐ heat capacity of the calorimeter.

☐ mass of the calorimeter and its contents.

☐ temperature change of the calorimeter and its contents.

22. The total number of atoms in 2 mol of $Na_2CO_3 \cdot 10(H_2O)$ is

☐ $2 \times 22.4 \times 6.02 \times 10^{23}$

☐ $2 \times 23 \times 6.02 \times 10^{23}$

☐ $2 \times 27 \times 6.02 \times 10^{23}$

☐ $2 \times 36 \times 6.02 \times 10^{23}$

23. A chemist working for a toothpaste firm wishes to prepare 250 cm^3 of a 0.010 M (mol/liter) aqueous solution of tin (II) fluoride. Fortunately for her, tin (II) fluoride is soluble in water. One mole of tin (II) fluoride weighs 156.7 g. Equipment available includes a 250 cm^3 volumetric flask, a 10 cm^3 pipette, a 0.01 g sensitivity balance, and a 400 cm^3 beaker.

Once the appropriate amount of tin (II) fluoride has been weighed, which one of the following procedures would be best?

☐ Place the tin (II) fluoride in the beaker and add exactly 250 cm^3 of water from the volumetric flask.

☐ Place the tin (II) fluoride in the volumetric flask, dissolve it in less than 250 cm^3 of water, and then dilute to the 250 cm^3 mark.

☐ Place the tin (II) fluoride in the beaker and add exactly 250 cm^3 of water from the pipette in 10 cm^3 portions.

☐ Using the beaker and balance, weigh out exactly 250 g of water and add the tin (II) fluoride to it.

☐ Dissolve the tin (II) fluoride in more than 250 cm^3 of water in the beaker and then fill the volumetric flask to the line with the solution.

24. The property of gases that accounts for pressure is

☐ the space between molecules.

☐ the density of the gas.

☐ the motion of the gas molecules.

☐ the identity of the gas.

25. A ball is thrown horizontally from the top of a cliff. Before the ball hits the ground, it (neglecting air resistance)

☐ accelerates vertically only.

☐ accelerates horizontally only.

☐ accelerates both vertically and horizontally.

☐ does not accelerate.

26. A boat travels at 18 km/h directly toward the opposite bank of a 40m wide stream in which there is a steady current running at 10 km/h. How far is the boat carried downstream before reaching the opposite shore if the boat stays pointing directly across the stream?

☐ 22 m

☐ 7.0 m

☐ 4.5 m

☐ 72 m

☐ 50 m

27. Millikan was able to determine the charge of an electron by balancing which forces?

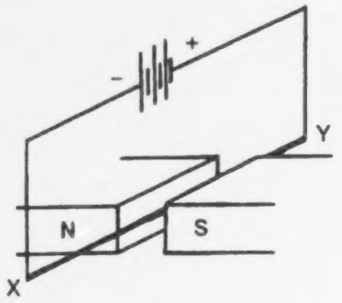
☐ Electric and magnetic

☐ Magnetic and centripetal

☐ Electric and gravitational

☐ Magnetic and gravitational

28. A wire with an electric current passing through it is placed in a magnetic field as shown in the diagram. In which direction will the wire move?



☐ towards the North pole

☐ towards the South pole

☐ vertically up

☐ vertically down

☐ in the direction of point Y

29. Scientists once thought that all matter existed forever. They now think that matter can be transformed and that energy will be released. Why has their understanding of matter changed?

☐ New knowledge was used to improve their understanding.

☐ Later experiments were not performed as carefully.

☐ There has been a change in the way matter and energy behave.

☐ Early scientists had no information about matter.

30. If the specific heat capacity of aluminum is 900 J/(kg·°C), the heat energy required to increase the temperature of 10.0 g of aluminum from 15°C to 20°C is

☐ 4.5×10^1 J
☐ 1.4×10^2 J
☐ 1.8×10^2 J
☐ 3.2×10^2 J
☐ 4.5×10^4 J

31. Which optical device may form an enlarged image?

☐ plane mirror
☐ glass plate
☐ converging lens
☐ diverging lens

32. The ether concept was originally introduced to explain the

☐ high speed of light.
☐ passage of light through outer space.
☐ existence of discrete photons in electromagnetic radiation.
☐ equality of speed of all forms of electromagnetic radiation in a vacuum.

Form 1
Difficult

1. A meteor is best defined as

☐ the light produced by an exploding star.

☐ a comet-like object made of ice and dirt.

☐ a rock fragment entering Earth's atmosphere.

☐ a star entering Earth's atmosphere.

2. An astronaut who weighs 9.00×10^2 N on Earth travels to Planet X, which has the same radius as Earth. If the mass of Planet X is 1.98×10^{30} kg and the mass of the Earth is 5.98×10^{24} kg, then the factor by which the astronaut's weight has changed is expected to be

☐ 3.02×10^{-6}

☐ 2.72×10^{-3}

☐ 3.31×10^{5}

☐ 1.10×10^{11}

3. Infrared radiation produced by the warmed materials of the earth's surface are absorbed in the atmosphere chiefly by

☐ water vapor and oxygen.

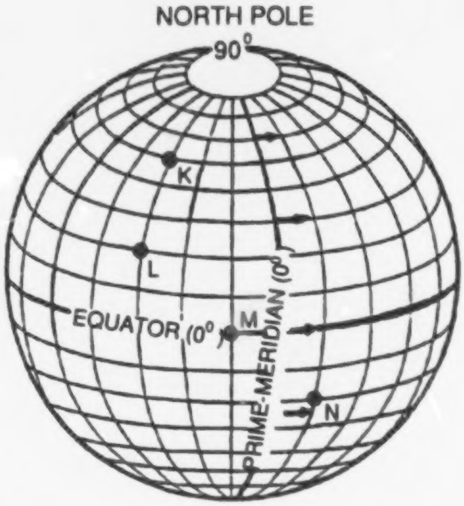
☐ water vapor and carbon dioxide.

☐ carbon dioxide and oxygen.

☐ oxygen and nitrogen.

4. The diagram below represents latitude and longitude lines on the surface of the Earth. Letters K through N represent sea level locations and the arrows show the direction of the Earth's rotation. The latitude lines shown are spaced 10° apart and the longitude lines are spaced 15° apart.

Which pair of locations (K, L, M, or N) would receive equal yearly insolation per square meter of surface if the atmosphere were completely transparent at each location?



☐ M, N

☐ K, L

☐ L, N

☐ L, M

☐ K, N

5. Which of the following pieces of equipment could be used to monitor the effect of acid rain on lake water?

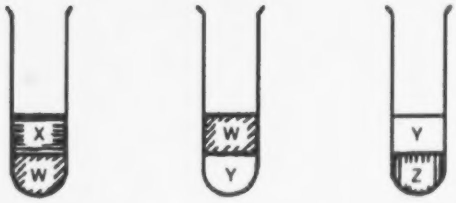
☐ A glass electrode.

☐ A platinum electrode.

☐ An oxygen electrode.

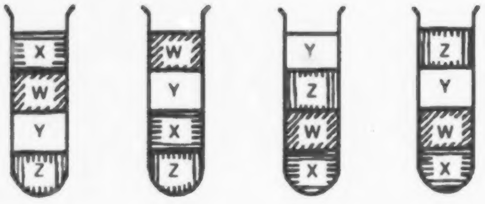
☐ A salt bridge.

6. Four liquids, W, X, Y, and Z, do not mix with each other when they are poured into test tubes as shown below in (1). The four liquids are poured into one test tube. Which diagram in (2) shows how the liquids will float in the test tube?



X floats on W W floats on Y Y floats on Z

(1)



A B C D

(2)

- ☐ A
- ☐ B
- ☐ C
- ☐ D

7. Of the following, which type of igneous rock formation is most useful in interpreting the rock record?

- ☐ extrusive formations
- ☐ intrusive formations
- ☐ lava flows
- ☐ lavalith

8. One reason it is believed that the polar regions once had a tropical climate is that

- ☐ fossils of tropical plants have been found there.
- ☐ evidence shows that the polar continents were once at the equator.
- ☐ the temperature of polar regions sometimes are as high as in the tropics.
- ☐ evidence indicates that snow was absent at one time in the polar regions.

9. Elongated epidermal cells present in the roots of plants function in the process of

- ☐ absorption.
- ☐ photosynthesis.
- ☐ reproduction.
- ☐ transpiration.

10. The two arms of a U-tube are separated by a barrier of dialysis membrane. If the left side of the tube contains a 6% sugar solution, and the right side contains a 10% sugar solution, then

- ☐ the level of the liquid will rise on the right side.
- ☐ the level of the liquid will rise on the left side.
- ☐ the concentrations of each side of the membrane will become equal, but the levels of the liquid will remain unchanged.
- ☐ the concentration of water molecules will increase on the left.
- ☐ sugar molecules will move from the left to the right.

11. Membranes of nerve axons are specialized to provide

☐ a resting potential difference resulting in a polarized membrane.

☐ respiratory enzymes capable of supplying energy rapidly.

☐ storage places for glycogen molecules.

☐ electric currents which can travel along the membrane.

☐ transmitter molecules along their full length.

12. Some doctors are now prescribing medications such as insulin and flu vaccines in the form of nasal sprays and nose drops. The advantages of using these methods include increased convenience and faster absorption. The reason for the rapid absorption of nasal sprays is that the nasal cavity has

☐ a close proximity to the control centers of the brain.

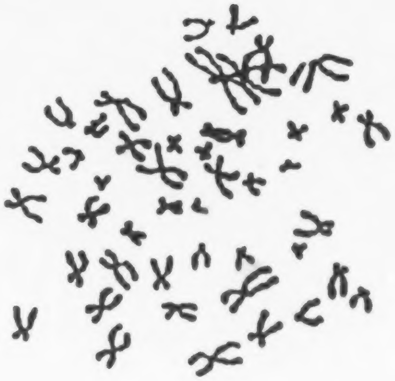
☐ many cilia that will transport the medication quickly.

☐ many odor receptors that absorb the medication.

☐ a high concentration of capillaries in its lining.

13. The diagram below represents a photographic enlargement of replicated chromosomes from a fetal cell.

For which technique would this photograph be used to determine if the chromosomes of the fetus exhibit any genetic abnormalities?



☐ cleavage

☐ karyotyping

☐ chemosynthesis

☐ plasmolysis

14. Color blindness is an X-linked recessive condition. Which parental genotypes below would result in children who are all normal daughters and all color-blind sons? (B = allele for normal color vision; b = allele for color blindness.)

☐ $X^BX^b - X^BY$

☐ $X^BX^B - X^bY$

☐ $X^BX^b - X^bY$

☐ $X^bX^b - X^bY$

☐ $X^bX^b - X^BY$

15. Although fossils provide evidence that many organisms once lived on earth and are now extinct, there are still many gaps in the fossil record. This is due mainly to certain conditions that are necessary for fossilization to occur. These conditions include all of the following EXCEPT

☐ an organism becoming quickly buried by sediments before disintegrating.

☐ the organism having a hard and rigid skeleton.

☐ the activity of micro-organisms and scavengers being limited.

☐ the area not having much volcanic and earthquake activity.

16. Which structures would be considered homologous?

☐ the wing of a bat and the flipper of a whale

☐ the arm of a starfish and the foreleg of a horse

☐ the jointed appendages of a grasshopper and a human

☐ the wings of a bat and a butterfly

17. The maximum number of electrons that a single orbital of the 3d sublevel may contain is

☐ 5

☐ 2

☐ 3

☐ 4

18. Within a family in the periodic table, why is the metal with the lowest ionization energy usually the one with the highest atomic number?

☐ Larger atoms are less likely to be spherical.

☐ Larger atoms are less likely to pack close together.

☐ The heaviest particles have the greatest kinetic energies.

☐ The distance between the nucleus and the outer electrons is greatest for the heaviest atoms.

19. The products of any neutralization reaction are

☐ carbon dioxide and water.

☐ an acid and a base.

☐ a salt and water.

☐ sodium chloride and water.

20. An example of an oxidation process would be

☐ a chromium (II) ion forming a chromium (III) ion.

☐ a chlorine atom forming a chloride ion.

☐ oxygen gas, O_2, reacting to form ozone gas, O_3.

☐ a calcium ion forming a calcium atom.

21. A student prepared a solution of acidified $SnCl_2$(aq) and then titrated this solution with $KMnO_4$(aq). The student's data were recorded as shown in the table below. In order to calculate correctly the concentration of MnO_4^-(aq), in addition to the balanced chemical equation, one would use

I. concentration of $SnCl_2$ (aq)	0.0790 mol/L
II. volume of $SnCl_2$ (aq) solution prepared	100.0 mL
III. volume of acid added to $SnCl_2$ (aq)	3.0 mL
IV. volume of $SnCl_2$ (aq) solution used in the titration	10.0 mL
V. volume of $KMnO_4$ (aq) solution used in the titration	12.8 mL

☐ I, II, and V.

☐ I, IV, and V.

☐ I, II, IV, and V.

☐ I, II, III, IV, and V.

22. If 1 L of a gas at STP has a mass of 2.86 g, the molar mass of the gas is

☐ 2.86 g

☐ 22.4 g

☐ 64.1 g

☐ 286 g

23. The acid-base indicator methyl red, may be represented by HMr, and its ionization equilibrium may be represented by the equation $HMr = H^+ + Mr^-$. The table shows the colors that methyl red exhibits in solution at given hydrogen ion concentrations. According to the results in the table, the equilibrium constant for the indicator is approximately

COLOR	$[H^+]$
red	10^{-1}
red	10^{-2}
red	10^{-3}
orange	10^{-4}
yellow	10^{-5}
yellow	10^{-6}
yellow	10^{-7}
yellow	10^{-8}

☐ 1.0×10^{-8} mol/L

☐ 1.0×10^{-5} mol/L

☐ 1.0×10^{-4} mol/L

☐ 1.0×10^{-3} mol/L

24. An aqueous acid or base is said to be strong if it is

☐ highly concentrated.

☐ in a state of equilibrium.

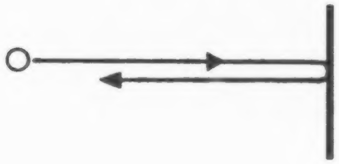
☐ highly hydrated.

☐ highly dissociated.

25. A car with a mass of 100 kg is moving with a constant velocity of 4 m/sec. What is its kinetic energy?

☐ 200 joules
☐ 400 joules
☐ 800 joules
☐ 1,600 joules
☐ 20,000 joules

26. The ball of mass 2 kg moving with a horizontal velocity of 5 m/s to the right hits a vertical wall and rebounds with a horizontal velocity of 4 m/s to the left as shown in the diagram below. The magnitude of the change in momentum of the ball, in kilogram meters per second, is



☐ 2
☐ 5
☐ 9
☐ 10
☐ 18

27. Millikan was able to determine the charge of an electron by balancing which forces?

☐ Electric and magnetic
☐ Magnetic and centripetal
☐ Electric and gravitational
☐ Magnetic and gravitational

28. Whenever a net charge is placed on a neutral object by contact, the predicted sign of the charge on the object

☐ is opposite to the charge on the charging agent.

☐ is the same as the charge on the charging agent.

☐ returns to neutral once the charging agent is removed.

☐ depends on the kind of material making up the object.

29. Scientists once thought that all matter existed forever. They now think that matter can be transformed and that energy will be released. Why has their understanding of matter changed?

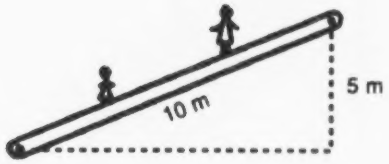
☐ New knowledge was used to improve their understanding.

☐ Later experiments were not performed as carefully.

☐ There has been a change in the way matter and energy behave.

☐ Early scientists had no information about matter.

30. The escalator shown below is used to move 20 passengers a minute from the first floor of a department store to the second floor, 5 m above. If the average mass of the passengers is 60 kg, the power required to move them is approximately



☐ 100 W
☐ 200 W
☐ 1,000 W
☐ 2,000 W
☐ 60,000 W

31. The following are hypotheses concerning the nature of electromagnetic waves:

I. Electromagnetic waves carry energy.

II. Electromagnetic waves can be reflected.

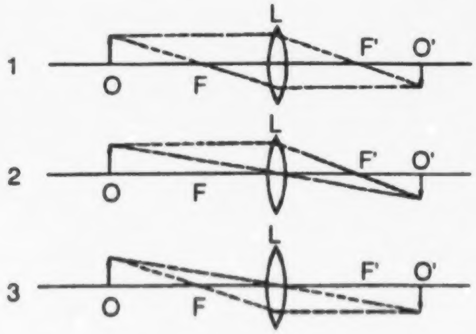
III. Electromagnetic waves travel through space as changing electric and magnetic fields.

IV. Electromagnetic waves travel at different speeds in a vacuum depending on their frequency.

The hypotheses consistent with experimental data are

☐ I and II only.
☐ II and III only.
☐ I, II, and III only.
☐ II, III, and IV only.

32. The three Diagrams 1, 2, 3, give the graphical construction for image O′ of object O as produced by the thin lens L with foci F and F′. Which, if any, of these three diagrams are correct?



☐ Only Diagrams 2 and 3 are correct.
☐ Only Diagrams 1 and 3 are correct.
☐ Only Diagrams 1 and 2 are correct.
☐ None of the diagrams is correct.
☐ All three diagrams are correct.

Form 1
More Difficult

1. The planet Neptune was discovered because

☐ of a photographic survey of the elliptic plane.

☐ of its proximity to Pluto.

☐ its gravitational effect caused small irregularities in the orbit of another planet.

☐ of the invention of a more powerful telescope.

2. A rocket is launched from the earth and travels to the upper limit of the earth's atmosphere. At this point its kinetic energy is 0.5×10^{10} J and its potential energy is -0.6×10^{10} J.

Which of the following statements is true?

☐ The vehicle will escape and its binding energy is 1.1×10^{10} J.

☐ The vehicle will escape and its binding energy is 0.1×10^{10} J.

☐ The vehicle will escape and have a kinetic energy after escape of 0.1×10^{10} J.

☐ The vehicle will escape and have a binding energy of -0.1×10^{10} J.

☐ The vehicle will not escape because it has a binding energy of 0.1×10^{10} J.

3. Convectional precipitation is caused by

☐ warm air rising from a heated surface.

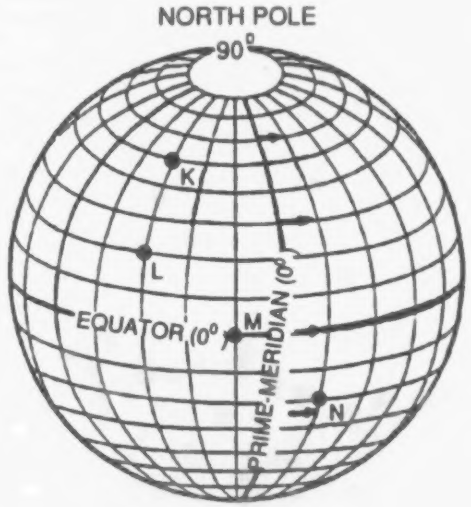
☐ air flowing up the side of a mountain.

☐ a clash of warm and cold air masses.

☐ warm air passing over a cold body of water.

4. The diagram below represents latitude and longitude lines on the surface of the Earth. Letters K through N represent sea level locations and the arrows show the direction of the Earth's rotation. The latitude lines shown are spaced 10° apart and the longitude lines are spaced 15° apart.

Which pair of locations (K, L, M, or N) would receive equal yearly insolation per square meter of surface if the atmosphere were completely transparent at each location?



☐ M, N

☐ K, L

☐ L, N

☐ L, M

☐ K, N

5. Four students determined the boiling point of pure water by boiling 5 beakers of water at sea level. The determinations were made during the same class period with the results shown below in °C. Which student obtained the most precise results?

Trial	Student A	Student B	Student C	Student D
1	101	100	104.5	105.15
2	99	99	97.5	102.85
3	102	100	101.5	102.25
4	98	98	100.0	97.95
5	100	98	101.0	101.80
Average reading	100	99	100.9	102.00
Spread	4	2	7.0	7.20

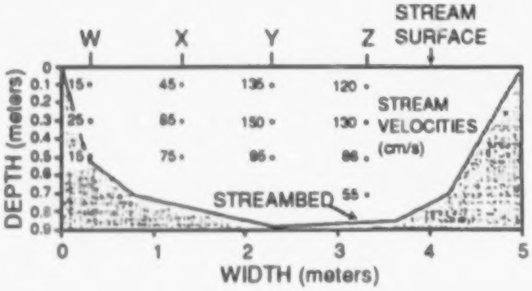
☐ A

☐ B

☐ C

☐ D

6. The diagram below represents a cross section of a shallow stream. Measured stream velocities, in centimeters per second, are shown at various points in the cross section. Which is the particle of largest size that the stream can keep in motion at location Z at a depth of 0.3 meter?


STREAM SURFACE
W
X
Y
Z
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
DEPTH (meters)
15
45
135
120
25
85
150
130
15
75
95
86
55
STREAM VELOCITIES (cm/s)
STREAMBED
0
1
2
3
4
5
WIDTH (meters)

☐ silt

☐ sand

☐ pebbles

☐ cobblestones

7. An element having a long half-life that can be used for radioactive dating of rocks is

☐ thorium-14

☐ strontium-87

☐ carbon-14

☐ protactinium-234

8. Which statement about earthquake waves best supports the inference that the Earth's outer core is liquid?

☐ The velocity of earthquake waves increases as the distance from an epicenter increases.

☐ Shear waves travel only through solids.

☐ Compressional waves travel faster than shear waves.

☐ The difference in arrival times for compressional and shear waves increases as the distance from an epicenter increases.

9. Elongated epidermal cells present in the roots of plants function in the process of

☐ absorption.

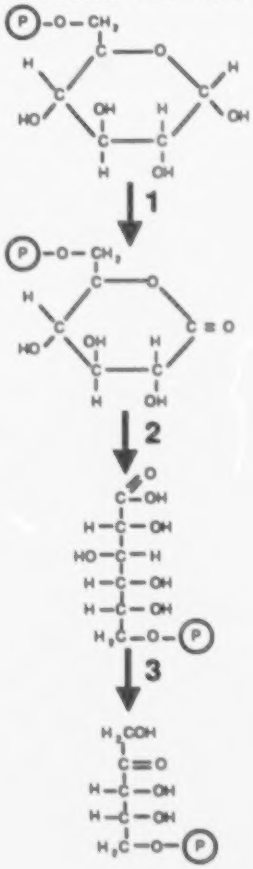
☐ photosynthesis.

☐ reproduction.

☐ transpiration.

10. The figure below shows three of a series of metabolic reactions occurring in cells. Where, in the sequence, would you expect NADP to be reduced as the reaction proceeds?

A SERIES OF CELLULAR METABOLIC REACTIONS



☐ reaction 1

☐ reaction 2

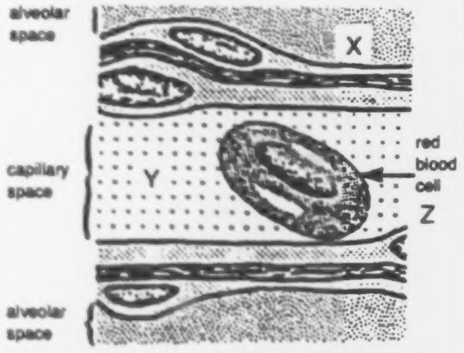
☐ reaction 3

☐ reaction 1 and also reaction 3

☐ reaction 1, reaction 2, and also reaction 3

11. According to the table below, low levels of carbon monoxide in inhaled air cause SIGNIFICANTLY reduced oxygen levels in the area(s) labeled

A Diagram of a Capillary in a Human Lung


alveolar space
X
capillary space
Y
red blood cell
Z
alveolar space

Hypothetical Data Based on the Above Diagram

Data Set	Substance Transferred From X to Y	Substance Transferred From Y to X	Substance Formed in Z	Effects of Transfer in Lung on Blood in Pulmonary Veins
I	CO_2	O_2	oxyhemoglobin	oxygen concentration is up
II	CO_2	O_2	carbamino-hemoglobin	oxygen concentration is down
III	O_2	CO_2	oxyhemoglobin	carbon dioxide concentration is down
IV	O_2	CO_2	carbamino-hemoglobin	carbon dioxide concentration is up

☐ X only.

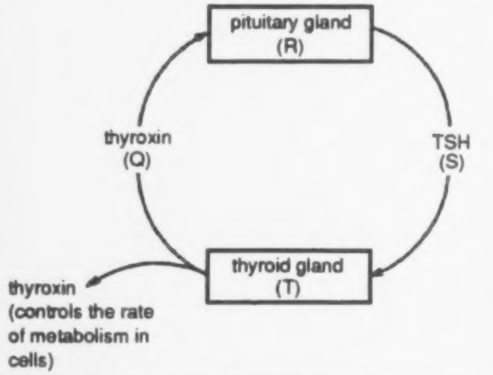
☐ Z only.

☐ X and Y.

☐ X and Z.

12. A CORRECT interpretation of the diagram below is that a higher

Feedback Regulation of Pituitary and Thyroid Gland Secretions


pituitary gland
(R)
thyroxin
(Q)
TSH
(S)
thyroid gland
(T)
thyroxin
(controls the rate
of metabolism in
cells)

☐ metabolic rate in cells induces T to produce more Q.

☐ metabolic rate in cells induces T to produce less Q.

☐ level of Q induces R to produce more S.

☐ level of Q induces R to produce less S.

13. If the cells in the meristematic region of a root tip are observed under a light microscope, it is possible to determine the stage of mitosis of each cell when the material was prepared.

Features which enable this to be determined include all of the following EXCEPT

☐ the presence or absence of centrioles in the cell.

☐ the presence of a nuclear membrane and nucleolus.

☐ the arrangement of any chromosomes visible.

☐ whether or not any distinct chromosomes are visible.

14. In a certain species of animals, black fur (B) is dominant and white fur (b) is recessive. The percentage of white animals (bb) is 36 percent. According to the Hardy-Weinberg Principle, the percentage of heterozygous black animals would be

☐ 24%

☐ 48%

☐ 16%

☐ 36%

☐ 64%

15. Without knowing the common names of *Poa pratensis*, *Poa annua*, and *Poa autumnalis*, you know that these organisms are in the same

☐ class.

☐ family.

☐ genus.

☐ order.

16. Which of the following best represents the principle that ontogeny recapitulates phylogeny?

☐ the similarity of human and bird embryos at early stages of development

☐ the passing of inherited characteristics from one generation to the next

☐ the similarity of adult organisms sharing a common ancestor

☐ the classification of organisms into kingdoms, phyla, classes, and orders

17. The Periodic Table, based on an octet pattern, lead Mendeleev to predict the existence of an element which he referred to as eka-silicon. This element is now known as

☐ sodium.

☐ gallium.

☐ germanium.

☐ neptunium.

18. Within a family in the periodic table, why is the metal with the lowest ionization energy usually the one with the highest atomic number?

☐ Larger atoms are less likely to be spherical.

☐ Larger atoms are less likely to pack close together.

☐ The heaviest particles have the greatest kinetic energies.

☐ The distance between the nucleus and the outer electrons is greatest for the heaviest atoms.

8:

19. An operating lead storage battery involves the two half-reactions listed below. When a lead storage battery is discharged,

$$PbO_2(s) + SO_4^{2-}(aq) + 4H^+(aq) + 2e^- \rightarrow PbSO_4(s) + 2H_2O(l)$$
$$E^\circ = +1.68\ V$$

$$PbSO_4(s) + 2e^- \rightarrow Pb(s) + SO_4^{2-}(aq)$$
$$E^\circ = -0.36\ V$$

☐ lead(IV) oxide is consumed.

☐ lead is produced.

☐ lead(II) sulfate is consumed.

☐ sulfuric acid concentration increases.

20. Which type of reaction is represented by the equation below?

$$C_6H_{12}O_6 \xrightarrow{\text{zymase}} 2C_2H_5OH + 2CO_2$$

☐ saponification

☐ fermentation

☐ esterification

☐ polymerization

21. A student prepared a solution of acidified $SnCl_2(aq)$ and then titrated this solution with $KMnO_4(aq)$. The student's data were recorded as shown in the table below. In order to calculate correctly the concentration of $MnO_4^-(aq)$, in addition to the balanced chemical equation, one would use

I.	concentration of $SnCl_2$ (aq)	0.0790 mol/L
II.	volume of $SnCl_2$ (aq) solution prepared	100.0 mL
III.	volume of acid added to $SnCl_2$ (aq)	3.0 mL
IV.	volume of $SnCl_2$ (aq) solution used in the titration	10.0 mL
V.	volume of $KMnO_4$ (aq) solution used in the titration	12.8 mL

☐ I, II, and V.

☐ I, IV, and V.

☐ I, II, IV, and V.

☐ I, II, III, IV, and V.

22. In an electrochemical cell with zinc and lead as electrodes, 3.0 A are generated for 6.0 h. The mass lost at the anode is

☐ 1.4×10^2 g

☐ 8.8×10^1 g

☐ 4.4×10^1 g

☐ 2.2×10^1 g

23. By what factor would the concentration of hydrogen (hydronium) ions be decreased if the pH of a solution changed from 2.0 to 4.0?

- ☐ 2
- ☐ 6
- ☐ 8
- ☐ 20
- ☐ 100

24. An ideal gas is compressed at constant temperature from 1.0 atm to 2.0 atm. What happens to the number of molecular collisions and to the average momentum per collision with the walls of the container?

	Number of Collisions	Average Momentum per Collision
A	increases	stays the same
B	increases	increases
C	decreases	stays the same
D	stays the same	stays the same

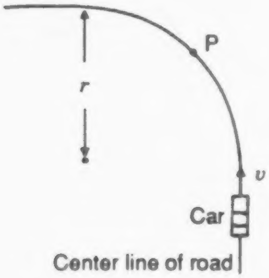
- ☐ A
- ☐ B
- ☐ C
- ☐ D

25. When a number of forces are applied to an object, the acceleration produced is

- ☐ equal to the numerical sum of the forces acting on the object.
- ☐ equal to the unbalanced force acting on the object.
- ☐ directly proportional to the mass of the object.
- ☐ directly proportional to the unbalanced force acting on the object.
- ☐ directly proportional to the product of the mass and the unbalanced force on the object.

26. A car is about to turn an unbanked corner of radius r, as shown, at constant speed v. Inside the car are two balloons. The lighter balloon is filled with a gas less dense than air and fastened by a string to the floor. The heavier balloon is filled with a gas more dense than air and hung by a string from the ceiling. Both balloons are located in the middle of the car when the car travels in a straight line. The balloons are free to swing right or left within the car.

When the car is at point P on the curve,



☐ both balloons are in the middle of the car.

☐ both balloons lean toward the inside of the curve.

☐ both balloons lean toward the outside of the curve.

☐ the lighter balloon leans toward the inside of the curve while the heavier balloon leans toward the outside.

☐ the heavier balloon leans toward the inside of the curve while the lighter balloon leans toward the outside.

27. The conclusion from the Millikan oil drop experiment was that

☐ the mass to charge ratio of the electrons is very small.

☐ there exists a smallest electric charge.

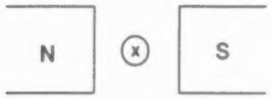
☐ the electron has a negative charge.

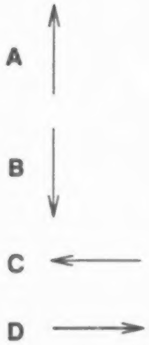
☐ the proton has a positive charge.

☐ the speed of the electrons is very great.

28. The diagram below illustrates a straight wire conductor situated between the poles of a permanent magnet. The poles of the magnet are in the plane of the page, and the wire is perpendicular to the plane of the page. The wire is carrying an electron flow away from you into the plane of the page as indicated by the cross.

The direction of the magnetic force on the wire is





E the same as the electron flow

☐ A

☐ B

☐ C

☐ D

☐ E

29. A student knows the specific heat capacity of water from previous experiments. During the laboratory determination of the specific heat capacity of a metal by the method of mixtures, the student measures the following:

1. the mass of cold water in a cup
2. the initial and final temperature of the water in the cup
3. the mass of the metal

What additional measurement is needed to determine the specific heat capacity of the metal?

☐ the volume of cold water in the cup

☐ the final temperature of the metal sample

☐ the initial temperature of the metal sample

☐ the mass of the boiling water

☐ the specific heat capacity of the water

30. The order of magnitude of the kinetic energy of a proton having mass 2×10^{-27} kg and traveling at 3×10^{6} m/s is

☐ 10^{-11} J

☐ 10^{-14} J

☐ 10^{-15} J

☐ 10^{-18} J

☐ 10^{-21} J

31. The interference pattern of monochromatic light is to be used to measure very small distances. Numerous clearly defined interference lines, as widely spaced as possible, are required.

Which of the following experimental conditions will produce the most suitable interference pattern?

☐ Green light incident on a wide single slit.

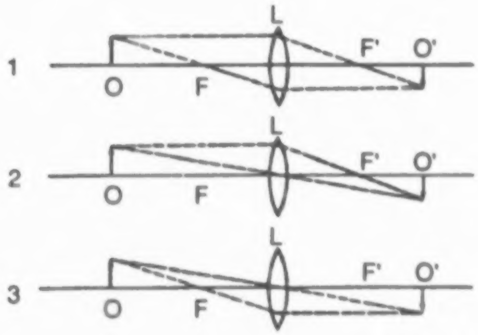
☐ Red light incident on a narrow single slit.

☐ Red light incident on a double slit which has a narrow slit width and a small distance between the slits.

☐ Red light incident on a double slit which has a wide slit width and a small distance between the slits.

☐ Blue light incident on a double slit which has a narrow slit width and a large distance between the slits.

32. The three Diagrams 1, 2, 3, give the graphical construction for image O′ of object O as produced by the thin lens L with foci F and F′. Which, if any, of these three diagrams are correct?



☐ Only Diagrams 2 and 3 are correct.

☐ Only Diagrams 1 and 3 are correct.

☐ Only Diagrams 1 and 2 are correct.

☐ None of the diagrams is correct.

☐ All three diagrams are correct.

Form 2
Easy

1. In which group are the bodies correctly listed in order of size, from largest to smallest?

☐ Sun, Moon, Earth

☐ Sun, Earth, Moon

☐ Earth, Moon, Sun

☐ Earth, Sun, Moon

2. Modern scientific thinking about the way the Solar System must have come into existence helps us predict that other solar systems

☐ are not likely to exist.

☐ cannot possibly exist.

☐ probably do exist.

☐ would be smaller than ours.

3. Information about which one of the following is most important in predicting weather?

☐ the available supplies of water

☐ the daily extremes of humidity

☐ the daily extremes of wind speed

☐ the daily extremes of temperature

☐ the movement and characteristics of air masses

4. What is the primary cause of Earth's weather?

☐ crustal plate movements

☐ Earth's rotation

☐ gravitational pull of the Moon

☐ energy from the Sun

5. Four students determined the boiling point of pure water by boiling 5 beakers of water at sea level. The determinations were made during the same class period with the results shown below in °C. The differences in the results obtained by the four students are most likely due to variations in the

Trial	Student A	Student B	Student C	Student D
1	101	100	101.5	100.15
2	99	99	99.5	101.85
3	102	100	101.5	100.25
4	98	98	100.2	99.95
5	100	98	101.0	101.80
Average reading	100	99	100.7	100.80
Spread	4	2	2.0	1.85

☐ accuracy with which the thermometers were read.

☐ boiling point of pure water at sea level.

☐ atmospheric pressure within the room.

☐ recording of the temperature to the nearest 0.01°C.

6. San Francisco Bay has a normal tide pattern. If it has a high-tide at 9:35 a.m., it will have its next low-tide about

☐ 12:00 noon.

☐ 3:35 p.m.

☐ 6:00 p.m.

☐ 9:35 p.m.

7. Volcanic activity that produces strings of islands like the Hawaiian chain is usually closely correlated with

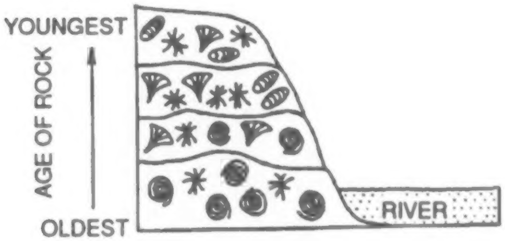
☐ movement of a crustal plate.

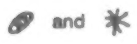
☐ sudden reversals in the Earth's magnetic field.

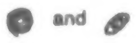
☐ frequent major changes in climate.

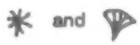
☐ frequent earthquake activity.

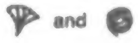
8. The diagram below shows fossils found in the layers of rock on a hillside. Which two fossil organisms lived at totally different times from each other?



A 

C 

B 

D 

☐ A

☐ B

☐ C

☐ D

9. Which of the following is true of cancer cells?

☐ Cell growth and division become uncontrolled.

☐ Cell division stops prematurely.

☐ Antibody production is stimulated.

☐ Differentiation is speeded up drastically.

10. The table below compares photosynthesis and respiration. Which of the comparisons is NOT correct?

	Photosynthesis	*Respiration*
A	Uses energy from light	Releases energy
B	Gives out oxygen	Gives out carbon dioxide
C	Goes on in the day only	Goes on in the night only
D	Occurs in green plants only	Occurs in all living cells
E	Uses water	Produces water

☐ A

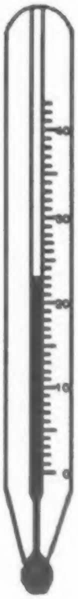
☐ B

☐ C

☐ D

☐ E

11. The diagram below represents a portion of a Celsius thermometer. What is the temperature in degrees Celsius indicated on the thermometer?



☐ 20.3

☐ 23.0

☐ 30.7

☐ 37.0

12. Which word best completes the statement below?

In humans, the circulatory system is to the heart as the respiratory system is to the

☐ lungs.

☐ kidneys.

☐ intestines.

☐ skin.

13. The table below shows the time taken for the breakdown of starch with an enzyme at different pH levels.

At what pH range is the action of this enzyme most rapid?

pH	Time taken in minutes
5	6
5.5	4
6	3
6.5	2
7	1.25
7.5	1.25
8	3

☐ pH 5–5.5

☐ pH 5.5–6

☐ pH 6–6.5

☐ pH 6.5–7

☐ pH 7–7.5

14. A living cell can grow by dividing into two, and each daughter cell can do the same. How many cells would there be after the cell divides 3 times?

☐ 4

☐ 6

☐ 8

☐ 15

☐ 16

15. Years after the lava from an erupting volcano destroyed an area, lichens started to grow in that area. These were gradually replaced by grasses, shrubs, conifers, and finally, by a deciduous forest.

The process described is known as

☐ photosynthesis.
☐ species preservation.
☐ ecological succession.
☐ conservation.

16. Assuming no other changes, population growth equals birth rate minus death rate. If the birth rate is 5 per cent per year and the death rate is 3 per cent per year, for every 1000 people at the beginning of the year how many will there be on average at the end of the year?

☐ 1000
☐ 1020
☐ 1030
☐ 1050
☐ 1080

17. A chemical element consists of

☐ one kind of compound.
☐ two or more kinds of compounds.
☐ one kind of atom.
☐ two or more kinds of atoms.

18. One of the characteristics of the solar system model of the atom is

☐ electrons are in orbits like planets.
☐ electrons are heavier than neutrons.
☐ neutrons are in orbits like planets.
☐ most of the mass of the atom is in the outer shells.

19. A chemical cell is made up of two half-cells connected by a salt bridge and an external conductor. What is the function of the salt bridge?

☐ to prevent the migration of ions
☐ to permit the migration of ions
☐ to permit the mixing of solutions
☐ to prevent the flow of electrons

20. A tree is chopped down, cut into pieces, and then burned. Which terms show the correct order of the changes that have occurred?

☐ physical, physical, physical
☐ physical, physical, chemical
☐ physical, chemical, chemical
☐ chemical, chemical, chemical

21. Which piece of equipment usually is used to measure the mass of an object?

☐ a beaker
☐ a metric ruler
☐ a thermometer
☐ a laboratory balance

22. How many calories of heat energy are absorbed in raising the temperature of 10 grams of water from 5.0°C to 20.0°C?

☐ 2.5×10^2

☐ 2.0×10^2

☐ 5.0×10^1

☐ 1.5×10^2

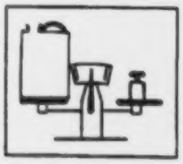
23. Ice is an example of which phase of matter?

☐ gas

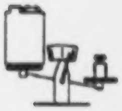
☐ liquid

☐ solid

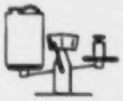
24. Diagram X shows an activity in which a large open container full of air is placed on a balance. The container is removed, heated, sealed, cooled and placed on the balance again. Which diagram (A, B, or C) shows how the balance will then look?



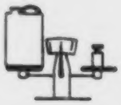
X



A



B



C

☐ A

☐ B

☐ C

25. Roller bearings or ball bearings are used in machines in order to reduce

☐ friction.

☐ weight.

☐ electrical shock.

☐ air resistance.

26. All of the following are simple machines except

☐ a lever.

☐ a pulley.

☐ a gear wheel.

☐ a gasoline powered motor.

27. Mechanical energy can be changed to electrical energy using a(n)

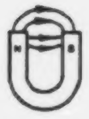
☐ armature.

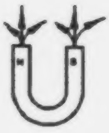
☐ generator.

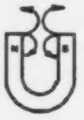
☐ transformer.

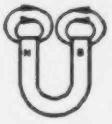
☐ motor.

28. Which diagram best represents the magnetic field near the poles of a horseshoe magnet?


1


2


3


4

☐ 1

☐ 2

☐ 3

☐ 4

29. Which of the following energy transformations take place in a dry cell?

☐ chemical to electrical

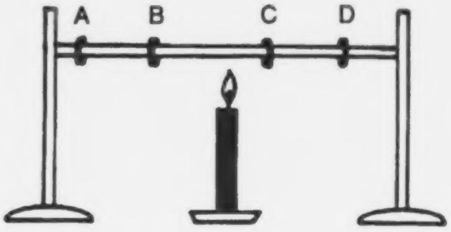
☐ chemical to nuclear

☐ electrical to chemical

☐ gravitational to electrical

☐ nuclear to chemical

30. The diagram below shows four wax rings placed on a metal rod that is being heated by a flame. Which wax ring will melt first?



☐ A

☐ B

☐ C

☐ D

31. Which of the following is NOT part of the electromagnetic spectrum?

☐ infrared

☐ radio wave

☐ sound wave

☐ light wave

☐ X-ray

32. The data table below shows the speed of sound in different materials. Which conclusion about the speed of sound in different materials is best made from the data table?

SPEED OF SOUND

Material	Speed (meters per second)
Air	331
Aluminum	5000
Carbon dioxide gas	259
Water	1486
Wood (oak)	3850

☐ Sound travels fastest through gases.
☐ Sound travels fastest through solids.
☐ Sound travels slowest through solids.
☐ Sound travels slowest through liquids.

Form 2
Intermediate

1. A satellite orbits the Earth in a circular orbit. Which statement best explains why the satellite does not move closer to the center of the Earth?

☐ The gravitational field of the Earth does not reach the satellite's orbit.

☐ The Earth's gravity keeps the satellite moving with constant velocity.

☐ The satellite is always moving perpendicularly to the force due to gravity.

☐ The satellite does not have any weight.

2. Modern scientific thinking about the way the Solar System must have come into existence helps us predict that other solar systems

☐ are not likely to exist.

☐ cannot possibly exist.

☐ probably do exist.

☐ would be smaller than ours.

3. If you were rising in a balloon, which of the following measurements would be most useful to you in determining your altitude?

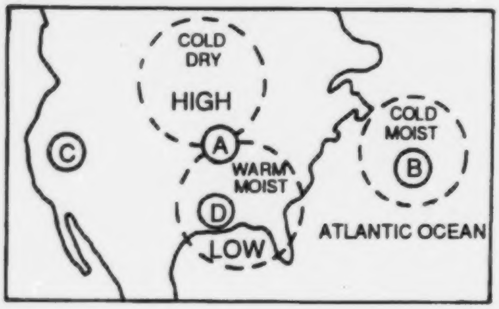
☐ the air temperature at your altitude

☐ the air pressure at your altitude

☐ the relative humidity at your altitude

☐ the absolute humidity at your altitude

4. The large circles in the diagram below show the location of three separate airmasses over North America. A front would be located at



☐ A

☐ B

☐ C

☐ D

5. In using the amount of salt in the ocean to determine its age, it is assumed that

☐ at one time ocean water began as fresh water.

☐ there was once much more salt in the Earth's surface.

☐ the salt could enter and leave the sea water at the same rate.

☐ animal fossils contributed salt to the ocean.

6. San Francisco Bay has a normal tide pattern. If it has a high-tide at 9:35 a.m., it will have its next low-tide about

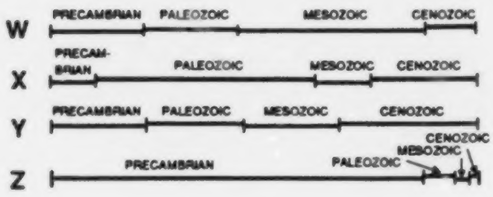
☐ 12:00 noon.

☐ 3:35 p.m.

☐ 6:00 p.m.

☐ 9:35 p.m.

7. Which line is the best representation of the relative duration of the geologic time intervals?


W
PRECAMBRIAN
PALEOZOIC
MESOZOIC
CENOZOIC
X
PRECAM-BRIAN
PALEOZOIC
MESOZOIC
CENOZOIC
Y
PRECAMBRIAN
PALEOZOIC
MESOZOIC
CENOZOIC
Z
PRECAMBRIAN
PALEOZOIC
MESOZOIC
CENOZOIC

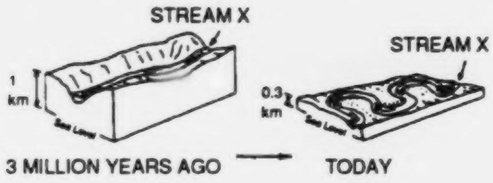
☐ W

☐ X

☐ Y

☐ Z

8. The diagrams below show the same part of Earth's crust as it may have looked 3 million years ago and as it looks today. Which statement best explains the change shown?


STREAM X
1 km
Sea Level
STREAM X
0.3 km
Sea Level
3 MILLION YEARS AGO
TODAY

☐ The height above sea level has become greater.

☐ The speed of the stream has increased.

☐ The climate has become colder.

☐ The rock material has worn away.

9. The step in photosynthesis immediately concerned with light is the

☐ regeneration of chlorophyll.

☐ excitation of chlorophyll.

☐ transfer of energy from chlorophyll to water.

☐ fixation of carbon dioxide.

☐ production of energy.

10. Which of the following statements about active transport are true?

I. It moves chemicals through membranes.

II. It can move chemicals from a high concentration to a lower concentration.

III. The cell must provide energy in the form of ATP.

IV. It is usually quite selective.

V. It only occurs across living membranes.

Select your response from the following:

☐ I, III, V only.

☐ I, III, IV, V only.

☐ II, III, IV, V only.

☐ I, II, III, IV, and V.

☐ I and V only.

11. When should a person's heart rate be recorded to best study the effect of exercise on heart rate?

☐ during exercise, only

☐ before exercise and during exercise, only

☐ during exercise and after exercise, only

☐ before, during, and after exercise

12. A patient is diagnosed as suffering from high blood pressure. The physician chooses to treat the patient with a drug that is OPPOSITE in function to antidiuretic hormone (ADH) because the drug will

☐ increase the reabsorption of water, which will lower the blood volume.

☐ decrease the reabsorption of water, which will lower the blood volume.

☐ decrease the reabsorption of water, which will raise the blood volume.

☐ increase the reabsorption of water, which will raise the blood volume.

13. Which laboratory procedure has made possible the development of bacteria that can synthesize human insulin?

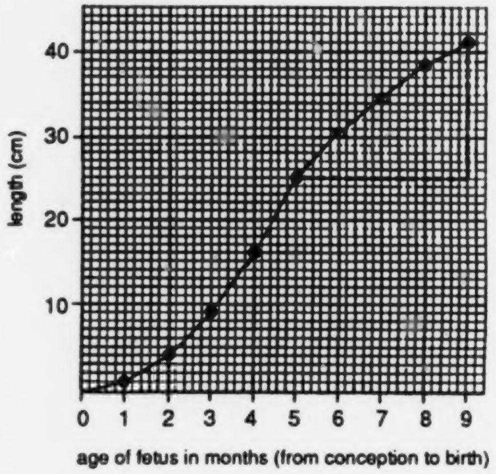
☐ genetic engineering

☐ karyotyping

☐ amniocentesis

☐ screening of body fluids

14. The graph below shows the growth of a human fetus before birth. What is the average rate of growth (in cm/month) of the fetus between the fifth and ninth months (as shown by the dotted lines)?



☐ 4 cm/month

☐ 5 cm/month

☐ 6 cm/month

☐ 7 cm/month

☐ 8 cm/month

15. Years after the lava from an erupting volcano destroyed an area, lichens started to grow in that area. These were gradually replaced by grasses, shrubs, conifers, and finally, by a deciduous forest.

The process described is known as

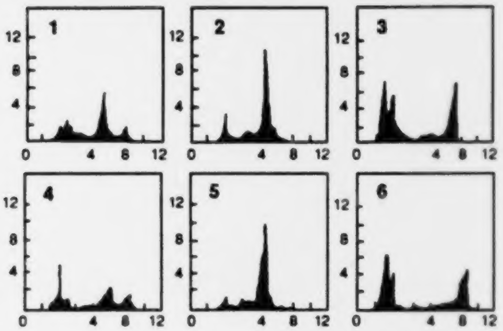
☐ photosynthesis.

☐ species preservation.

☐ ecological succession.

☐ conservation.

16. Biochemists can sometimes tell how closely related two species are, in an evolutionary sense, by comparing homologous proteins. The figure below shows the drawings of electrophoretic patterns of the egg proteins of various birds. Which two are most likely to be two birds of the same genus?


ELECTROPHORETIC PATTERNS OF THE EGG PROTEINS OF BIRDS

☐ 1 and 2

☐ 1 and 4

☐ 2 and 5

☐ 4 and 6

☐ 3 and 6

17. The particles most directly involved in forming chemical bonds are

☐ electrons.

☐ neutrons.

☐ photons.

☐ positrons.

☐ protons.

18. The atomic number of an element refers to

☐ the number of atoms in 1 g of the element.

☐ the mass of an atom of the element.

☐ the number of atoms in a molecule of the element.

☐ the number of protons in an atom of the element.

19. A solution of substance X is added to a solution of substance Y. No color change is observed. Which of the following would provide evidence that a chemical reaction had taken place although there was no change in color?

☐ Any product is soluble in water.

☐ The solutions of X and Y can be mixed in all proportions and still give the same result.

☐ There is a rise of temperature when the two solutions are mixed.

☐ The final liquid is shown to be neutral by using an indicator.

☐ The experiment gives the same result when different concentrations of the two solutions are used.

20. "The total mass of reactants equals the total mass of products" is a statement of the

☐ law of definite proportions.

☐ law of multiple proportions.

☐ law of conservation of energy.

☐ law of conservation of mass.

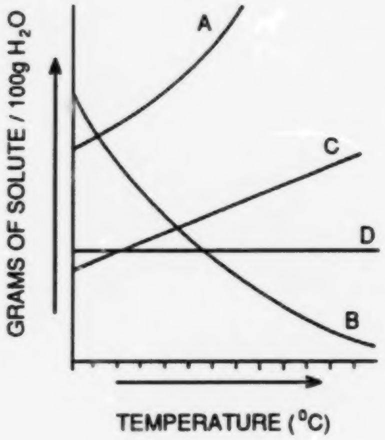
21. Which piece of equipment usually is used to measure the mass of an object?

☐ a beaker
☐ a metric ruler
☐ a thermometer
☐ a laboratory balance

22. Which one of the following equations is balanced?

☐ $2H_2O + Ca \rightarrow Ca(OH)_2 + H_2$
☐ $H_2O + Na \rightarrow NaOH + H_2$
☐ $Zn + H_2SO_4 \rightarrow ZnSO_4 + 2H_2$
☐ $2KClO_3 \rightarrow KCl + 3O_2$

23. The graph below represents four solubility curves. Which curve best represents the solubility of a gas in water?



☐ A
☐ B
☐ C
☐ D

24. Solder is a mixture of lead and tin but the percentages of lead and tin can vary. Different kinds of solder were melted and then allowed to go solid. The data in the table were obtained by plotting cooling curves as the solders solidified. From these data it can be concluded that all solders

Solder	Composition % lead	% tin	Temperature at which solidification begins (°C)	Temperature at which solidification ends (°C)
W	67	33	265	183
X	50	50	220	183
Y	38	62	183	183
Z	20	80	200	183

☐ start to solidify at a constant temperature.

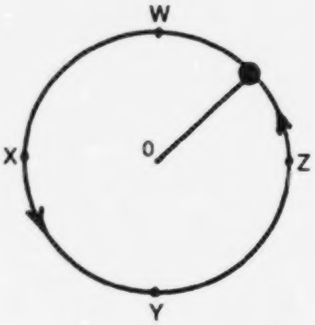
☐ will start to melt at the same temperature.

☐ contain the same amounts of lead and tin.

☐ will become completely liquid at the same temperature.

25. The diagram shows an object tied to the end of a string moving counterclockwise in a circle at constant speed on a frictionless level surface. The distance traveled by the object in moving from W to X is 25 m. It takes the object 20 s to complete one revolution.

If the string breaks when the object is at Z, the object will



☐ move outward from the center of the circle at constant speed.

☐ move inward toward the center of the circle at constant speed.

☐ continue to move in a circle at constant speed.

☐ move along the tangent to the circle at point Z with constant speed.

☐ move along the tangent to the circle at point Z with decreasing speed.

26. Inertial mass differs from gravitational mass in that the total inertial mass

☐ is directly proportional to the volume of a pure substance.

☐ can be measured only when there is a change of motion.

☐ is not conserved in chemical reactions.

☐ is not additive for a number of different pure substances.

☐ can be measured only when there is uniform motion.

27. The unit representing the rate of flow of electric charge is the

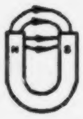
☐ volt.

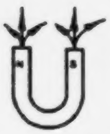
☐ ohm.

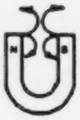
☐ ampere.

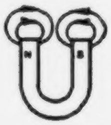
☐ coulomb.

28. Which diagram best represents the magnetic field near the poles of a horseshoe magnet?


1


2


3


4

☐ 1

☐ 2

☐ 3

☐ 4

29. Food and liquids heated in a microwave oven get the energy by

☐ conduction through metal.

☐ convection of hot air.

☐ absorption of radiation.

☐ the addition of a catalyst.

30. In an imaginary situation, a 1 kg block of ice at 0 °C is dropped from such a height that all of it is melted by the heat generated on impact with the ground. From what height would a 25 kg block of ice have to be dropped to melt completely? Assume that in both cases all of the heat produced is absorbed by the ice.

☐ 1/5 as high

☐ 1/25 as high

☐ the same height

☐ 5 times as high

☐ 25 times as high

31. This item involves two statements:

I. As you move away from a light source the intensity of the light decreases.

II. There is an inverse square law relationship between the intensity of light and the distance from the light source.

Which of the following responses correctly describes the two statements?

☐ Both statements are true.

☐ Statement I is true. Statement II is false.

☐ Statement I is false. Statement II is true.

☐ Statement I is false. Statement II is false.

32. What is the period of a wave with a frequency of 2.0 $\times 10^2$ hertz?

☐ 6.0×10^{-10} s

☐ 2.0×10^{-3} s

☐ 5.0×10^{-3} s

☐ 1.5×10^{6} s

Form 2
Difficult

1. This question involves two statements:

I. Astronauts experience "weightlessness" in a satellite orbiting the earth.

II. The gravitational force exerted by the earth on astronauts is zero.

Which of the following responses correctly describes the two statements?

- ☐ Both statements are true and one statement can be used to explain the other.
- ☐ Both statements are true, but neither statement can be used to explain the other.
- ☐ Statement I is true. Statement II is false.
- ☐ Statement I is false. Statement II is true.
- ☐ Statement I is false. Statement II is false.

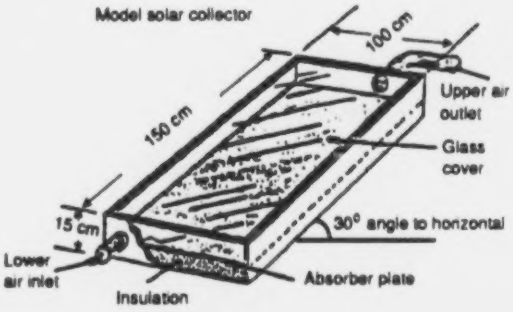
2. An astronaut traveling in space observes an object which seems to be rising toward the spaceship with uniform acceleration.

Which one of the following postulates should be immediately RULED OUT in attempting to explain the observation on the basis of physical principles?

- ☐ The object is being uniformly accelerated toward the ship because of gravitational attraction to it.
- ☐ The object is at rest and the astronaut is accelerating uniformly down toward it.
- ☐ The ship and the object are both in motion and either one, or both of them, are accelerating uniformly.
- ☐ The astronaut is accelerating uniformly toward a reflection of the ship caused by some unfamiliar reflecting surface.

3. The diagram below represents a hot-air solar collector consisting of a wooden box frame, an absorber plate, a glass cover, and insulation.

Why does the air usually enter the collector at the lower air inlet and leave the collector at the upper air outlet?



- ☐ The air inside the collector is cooler than the air in the lower air inlet.
- ☐ The air inside the collector is less dense than the air in the lower air inlet.
- ☐ The air inside the collector has less moisture than the air in the lower air inlet.
- ☐ The mass of the air inside the collector is greater than the mass of the air in the lower air inlet.
- ☐ The pressure of the air inside the collector is greater than the pressure of the air in the lower air inlet.

4. Of what importance to the hydrologic cycle are the tiny particles of dust found in the atmosphere?

- ☐ They aid in the processes of condensation and precipitation.
- ☐ They increase the amount of evaporation that takes place.
- ☐ They increase the amount of water the atmosphere can hold.
- ☐ They are the source of most of the dissolved salt in the sea.

5. Throughout the year, scientists keep detailed records of the temperature of the water of the surface of the Pacific Ocean off the coast of Peru. What is their main purpose in collecting these data?

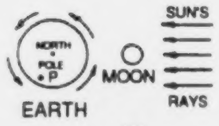
☐ To predict changes in coastal ocean currents.

☐ To estimate the size of the annual fishing catch.

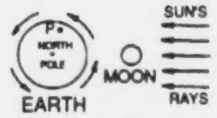
☐ For long-term prediction of the weather in parts of South America.

☐ All of the above.

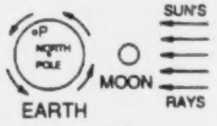
6. Which diagram shows the location of point P when it would have the highest tide?


NORTH POLE
P
MOON
SUN'S RAYS
EARTH

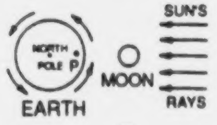
W


P
NORTH POLE
MOON
SUN'S RAYS
EARTH

Y


P
NORTH POLE
MOON
SUN'S RAYS
EARTH

X


NORTH POLE
P
MOON
SUN'S RAYS
EARTH

Z

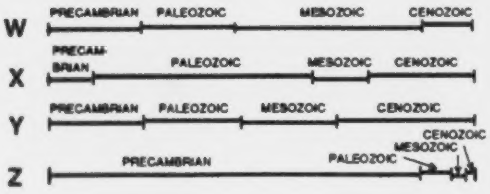
☐ W

☐ X

☐ Y

☐ Z

7. Which line is the best representation of the relative duration of the geologic time intervals?


W
PRECAMBRIAN
PALEOZOIC
MESOZOIC
CENOZOIC
X
PRECAMBRIAN
PALEOZOIC
MESOZOIC
CENOZOIC
Y
PRECAMBRIAN
PALEOZOIC
MESOZOIC
CENOZOIC
Z
PRECAMBRIAN
PALEOZOIC
MESOZOIC
CENOZOIC

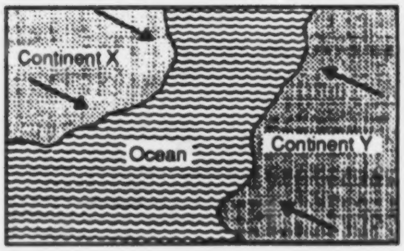
☐ W

☐ X

☐ Y

☐ Z

8. The diagram below shows two imaginary continents that are moving toward each other. Which change is most likely to occur as the continents collide?


Continent X
Ocean
Continent Y

☐ a decrease in the amount of faulting

☐ a decrease in the number of earthquakes

☐ an increase in the amount of mountain building

☐ an increase in the number of glaciers

9. The rate of diffusion of materials out of a cell is INDEPENDENT of the

☐ temperature of the cell.

☐ permeability of the cell membrane.

☐ amount of ATP present in the cell membrane.

☐ concentration difference on either side of the cell membrane.

10. Which of the following types of cells DO NOT continue to divide throughout life?

☐ Nerve cells

☐ Epithelial cells

☐ Bone cells

☐ Liver cells

11. When should a person's heart rate be recorded to best study the effect of exercise on heart rate?

☐ during exercise, only

☐ before exercise and during exercise, only

☐ during exercise and after exercise, only

☐ before, during, and after exercise

12. A regulatory mechanism involving a hormone is presented along with two conditions that may or may not be directly related to the regulatory mechanism. The mechanism and conditions are shown in the table. Which statement correctly identifies the relationship between the regulatory mechanism and the two conditions?

Regulatory Mechanism	Condition	
Thyroxin levels	First -	Surgical removal of a person's pituitary requires administration of pituitary hormones to increase metabolic rate.
	Second -	Drinking large amounts of alcohol results in a marked increase in urine excretion.

☐ The regulatory mechanism is related to both conditions.

☐ The regulatory mechanism is not related to either condition.

☐ The regulatory mechanism is related to the first condition but not the second.

☐ The regulatory mechanism is related to the second condition but not the first.

13. In 1984, scientists reported that protein crystals had been grown in an orbiting space laboratory, and that the crystals were 27 to 1000 times the volume of crystals grown at the earth's surface. Such crystals would be most useful in efforts to determine the protein's

☐ three-dimensional shape.

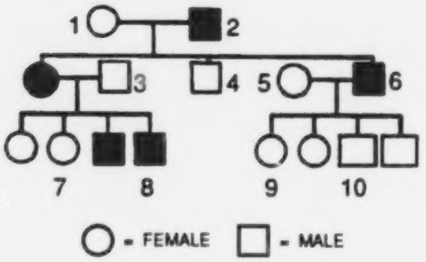
☐ mechanism of catalytic action.

☐ molecular weight.

☐ chemical composition.

☐ function within a cell.

14. A geneticist was investigating the pattern of inheritance for color blindness in human beings. In the following pedigree the shaded individuals are color blind. Which of the statements below is NOT correct?



☐ The mode of inheritance for color blindness is consistent with being inherited as a sex-linked recessive.

☐ Individuals 7 and 9 must be carriers of the allele for color blindness.

☐ Individuals 4 and 5 cannot be carriers of the allele for color blindness.

☐ Individual 6 has daughters who are carriers and any daughter of individual 8 must be a carrier of the allele for color blindness.

15. A vestigial organ is one that is

☐ reduced in form and in function.

☐ of great physiological importance.

☐ in the process of developing into a useful organ.

☐ found only in the embryo.

☐ peripherally located.

16. In 1946, a city sprayed DDT on city dumps and other breeding grounds of flies. This was immediately effective in reducing the number of house flies in the whole city area. Although the spraying was repeated in successive years, the number of flies gradually increased, approaching the former (1945) level in 1949. Which one of the following best explains this situation?

☐ Each new generation of young flies grew up with DDT as part of the environment and gradually developed immunity.

☐ Flies gradually found new breeding places not contaminated by DDT.

☐ DDT-resistant flies survived to breed, as did their offspring, until more and more of each year's flies were DDT-resistant.

☐ Flies exposed to non-lethal concentrations of DDT quickly learned to avoid food and other matter sprayed with DDT.

☐ Flies from nearby, non-sprayed areas soon migrated to the city area.

17. An element is in period 3 and family I of the periodic table. The atoms of this element have

☐ 1 valence and 10 core electrons.

☐ 3 valence and 6 core electrons.

☐ 3 valence and 8 core electrons.

☐ 5 valence and 10 core electrons.

18. An atomic orbital is best described as

☐ a volume in space.

☐ a probability function.

☐ an electron path.

☐ a set of concentric circles.

19. A student recorded observations regarding the colors of various indicators in an unknown acid solution. Which of these observations shown below is INCONSISTENT with the other observations?

I. The solution turns red with the addition of methyl red.
II. The solution turns blue with the addition of indigo carmine.
III. The solution turns blue with the addition of bromothymol blue.
IV. The solution turns neutral litmus paper red.

☐ Observation I
☐ Observation II
☐ Observation III
☐ Observation IV

20. "The total mass of reactants equals the total mass of products" is a statement of the

☐ law of definite proportions.
☐ law of multiple proportions.
☐ law of conservation of energy.
☐ law of conservation of mass.

21. The relative atomic mass of an element always has the same numerical value as the

☐ mass number.
☐ mass of one atom.
☐ mass of one molecule.
☐ mass of Avogadro's Number of atoms.

22. 2.00 ± 0.05 mol of element A has a mass of 92.6 ± 0.5 g. The molar mass of A is

☐ 46.3 ± 0.55 g.
☐ 46.3 ± 1.1 g.
☐ 46.3 ± 1.4 g.
☐ 46.3 ± 2.5 g.

23. The solubility of a gas in a liquid will be greatest at

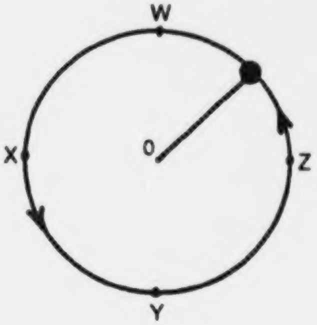
☐ low temperature and low pressure.
☐ high temperature and low pressure.
☐ high temperature and high pressure.
☐ low temperature and high pressure.

24. Consider an ideal gas with volume of V at a particular temperature and pressure. If the Kelvin temperature is doubled and the pressure is quadrupled, the new volume of the gas, expressed in liters, is

☐ V/2
☐ V
☐ 2V
☐ 4V

25. The diagram shows an object tied to the end of a string moving counterclockwise in a circle at constant speed on a frictionless level surface. The distance traveled by the object in moving from W to X is 25 m. It takes the object 20 s to complete one revolution.

If the string breaks when the object is at Z, the object will



☐ move outward from the center of the circle at constant speed.

☐ move inward toward the center of the circle at constant speed.

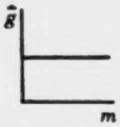
☐ continue to move in a circle at constant speed.

☐ move along the tangent to the circle at point Z with constant speed.

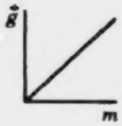
☐ move along the tangent to the circle at point Z with decreasing speed.

26. Near the surface of the earth, which graph best represents acceleration due to gravity $\vec{g}$ as a function of mass m?

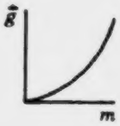
L



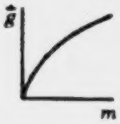
M



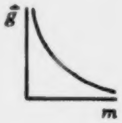
N



O



P



☐ L

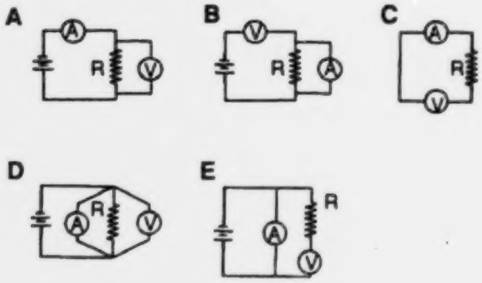
☐ M

☐ N

☐ O

☐ P

27. In the following circuits an ammeter (A), a voltmeter (V), a resistor (R) and a battery are shown. It is desired to measure the current passing through the resistor and the potential difference across it. In which one of the following circuits are the instruments connected correctly?



☐ A

☐ B

☐ C

☐ D

☐ E

28. Which of the following pairs of fields have equations of similar algebraic form to describe their intensity?

☐ The electric field of a point charge and the gravitational field of a point mass

☐ The magnetic field of a moving charge and the electric field of a point charge

☐ The electric field of a point charge and the magnetic field of a current-carrying wire

☐ The magnetic field of a current-carrying wire and the electric field between parallel plates

29. A Geiger counter operates on the principle that

☐ the ionization and deionization of certain crystals is accompanied by the emission of light.

☐ an electrically charged conductor will lose its charge in the presence of radioactivity.

☐ vapors condense more easily on charged particles than on uncharged particles.

☐ beta particles deionize a gas through which they pass.

☐ a neutral conductor becomes charged in the presence of radioactivity.

30. If the temperature of the air in a hot air balloon is increased from 27°C to 77°C, by what proportion will the lift of the balloon increase? (Hint: 0°C = -273°K)

☐ 16/15

☐ 7/6

☐ 6/5

☐ 7/5

☐ 4/3

31. An astronomer who observes the spectrum of an approaching star notices that the characteristic frequencies of the star's light have all increased (blue shift). This effect results from

☐ an increase in the speed of the light.

☐ an increase in the wavelength of the light.

☐ a decrease in the frequency of the light.

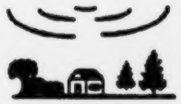
☐ a decrease in the period of the light.

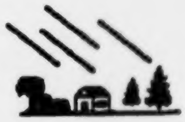
32. What is the period of a wave with a frequency of 2.0×10^2 hertz?

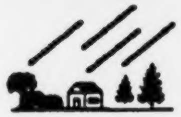
- ☐ 6.0×10^{-10} s
- ☐ 2.0×10^{-3} s
- ☐ 5.0×10^{-3} s
- ☐ 1.5×10^{6} s

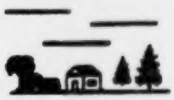
Form 2
More Difficult

1. An observer at 40° north latitude took a time exposure photograph from 10 p.m. until midnight of the stars over the northern horizon. Which diagram below best represents the photograph?

A


B


C


D


☐ A

☐ B

☐ C

☐ D

2. The moon does not presently have a magnetic field. This would indicate that

☐ it has a cold, solid interior.

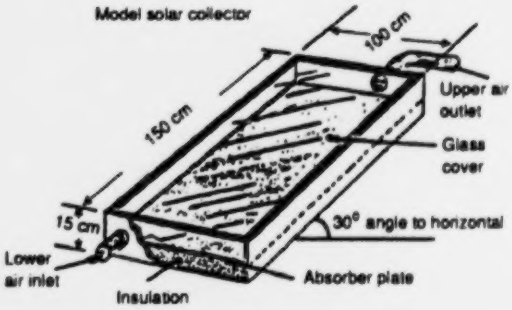
☐ it is in the middle of a magnetic reversal.

☐ it has a hot core.

☐ it has no gravity.

3. The diagram below represents a hot-air solar collector consisting of a wooden box frame, an absorber plate, a glass cover, and insulation.

Why does the air usually enter the collector at the lower air inlet and leave the collector at the upper air outlet?



☐ The air inside the collector is cooler than the air in the lower air inlet.

☐ The air inside the collector is less dense than the air in the lower air inlet.

☐ The air inside the collector has less moisture than the air in the lower air inlet.

☐ The mass of the air inside the collector is greater than the mass of the air in the lower air inlet.

☐ The pressure of the air inside the collector is greater than the pressure of the air in the lower air inlet.

4. The compositions of the atmosphere and hydrosphere are more uniform than that of the lithosphere because

☐ the lithosphere has a higher density.

☐ the lithosphere is composed of more substances.

☐ the lithosphere is not as old as the atmosphere and hydrosphere.

☐ the lithosphere is less fluid than the atmosphere and hydrosphere.

5. A rain gage has a circular precipitation collector 24 cm in diameter. Water entering the collector is measured by its height in a vertical tube 4 cm in diameter. The calculation for converting the height reading of 8 cm in the tube to centimeters of rainfall per unit area of ground is

- ☐ $(2^2 \times 8)/12^2$
- ☐ $(4 \times 8)/24$
- ☐ $(2^2 \times 8)/12^2\pi$
- ☐ $(4^2 \times 8)/24^2$

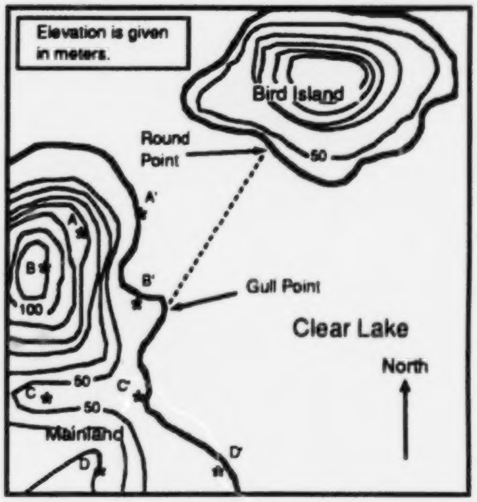
6. The water rising from hot springs in Yellowstone National Park cause deposits of limestone to build up at the surface. Which of the following facts explains this phenomenon?

- ☐ Water under pressure can hold more dissolved minerals than water at normal atmospheric pressure.
- ☐ Cold water can hold more dissolved gases than hot water.
- ☐ Hot water can hold more dissolved minerals than cold water.
- ☐ Water under pressure can hold more dissolved gases than water at normal atmospheric pressure.

7. Which type of rock is formed from the solidification of magma?

- ☐ igneous
- ☐ metamorphic
- ☐ sedimentary
- ☐ meta-sedimentary

8. Which letters on the topographic map below indicate the direction of a stream flowing into Clear Lake?



- ☐ A–A'
- ☐ B–B'
- ☐ C–C'
- ☐ D–D'

9. One would expect to find larger numbers of mitochondria in muscle cells than in skin cells because muscles

- ☐ are very elastic.
- ☐ are able to repair themselves quickly.
- ☐ require large amounts of energy.
- ☐ require large amounts of protein.

10. Which of the following types of cells DO NOT continue to divide throughout life?

- ☐ Nerve cells
- ☐ Epithelial cells
- ☐ Bone cells
- ☐ Liver cells

11. The artificial kidney machine is used to purify blood when the kidneys fail to do their work. A major functional difference between the artificial and the real kidney is that

☐ only the real kidney uses a semipermeable membrane.

☐ the artificial kidney cannot carry out active transport.

☐ the real kidney does not use diffusion to move molecules through a membrane.

☐ only the artificial kidney maintains a concentration gradient across a membrane.

12. A nerve impulse can be described as

☐ a changing electrochemical gradient along a neuron.

☐ a changing electrical gradient along a neuron.

☐ a changing chemical gradient along a neuron.

☐ a physical chain reaction along a neuron.

☐ an electric current flowing through a neuron.

13. A research scientist hopes to trace the movement of messenger RNA through cells using radioactively labeled RNA in a technique called autoradiography. The best compound to feed his test animals to induce them to manufacture radioactively labeled messenger RNA within their cells would be radioactively labeled

☐ thymine.

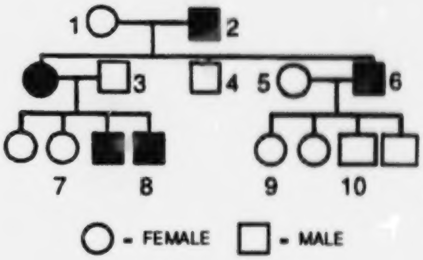
☐ guanine.

☐ cytosine.

☐ uracil.

☐ adenine.

14. A geneticist was investigating the pattern of inheritance for color blindness in human beings. In the following pedigree the shaded individuals are color blind. Which of the statements below is NOT correct?



☐ The mode of inheritance for color blindness is consistent with being inherited as a sex-linked recessive.

☐ Individuals 7 and 9 must be carriers of the allele for color blindness.

☐ Individuals 4 and 5 cannot be carriers of the allele for color blindness.

☐ Individual 6 has daughters who are carriers and any daughter of individual 8 must be a carrier of the allele for color blindness.

15. In the nitrogen cycle which of the following might be found in root nodules?

☐ Nitrogen-fixing bacteria

☐ Denitrifying bacteria

☐ Nitrifying bacteria

☐ Decay bacteria

☐ Ammonia-converting bacteria

16. Ten laboratory animals were kept in a cage and were measured from the time that they hatched until day 14. The average length of the animals on certain days is given in the table below. The laboratory animals could have been

Age in days	1	2	3	5	6	8	9	10	12	13	14
Average length (mm)	3	3	5	5	8	8	8	12	12	12	17

☐ cockroaches.
☐ mice.
☐ tadpoles.
☐ lizards.
☐ fish.

17. An element is in period 3 and family I of the periodic table. The atoms of this element have

☐ 1 valence and 10 core electrons.
☐ 3 valence and 6 core electrons.
☐ 3 valence and 8 core electrons.
☐ 5 valence and 10 core electrons.

18. An element with an electronegativity of 3.2 is most likely classified as a

☐ metal.
☐ nonmetal.
☐ semimetal (metalloid).
☐ noble gas.

19. Which of the following would you use to test for carbon dioxide?

☐ a glowing splint
☐ iodine
☐ lime water
☐ Fehling's solution

20. Which statement is true for these reactions?

$$\text{I} \quad O_2(g) + 2F_2(g) \longrightarrow 2OF_2(g)$$

$$\text{II} \quad O_3(g) + 3F_2(g) \longrightarrow 3OF_2(g)$$

Free Energies of Formation, ΔG°_f	
OF_2	40.6 kJ · mol⁻¹
O_3	164. kJ · mol⁻¹

☐ Reaction I is spontaneous, reaction II is not.
☐ Reaction II is spontaneous, reaction I is not.
☐ Both reactions are spontaneous.
☐ Neither reaction is spontaneous.

21. Kim and Tracy were assigned to make a standard solution of potassium permanganate and to use it to determine the concentration of tin(II) ion in a solution of unknown concentration.

Kim used 1.50 g and Tracy used 1.00 g of $KMnO_4$. Each amount was dissolved in enough water to make 250 mL of solution, and the solutions were allowed to stand for 24 h.

Both solutions of $KMnO_4$ were standardized against an acidic solution of iron(II) ion of known concentration and then used to determine the concentration of tin(II) ion in the solution of unknown concentration.

If both students followed correct procedures, the calculated value for the concentration of tin(II) ion was

☐ higher for Kim's experiment because his $[MnO_4^-(aq)]$ was higher than Tracy's.

☐ higher for Tracy's experiment because her $[MnO_4^-(aq)]$ was lower than Kim's.

☐ lower for Tracy's experiment because her $[MnO_4^-(aq)]$ was lower than Kim's.

☐ the same for both experiments within experimental uncertainty.

22. A student is given four test tubes labeled I through IV, each containing an aqueous solution of one of these:

0.1 M $CuCl_2$, 0.1 M $Al(NO_3)_3$, 0.1 M $AgNO_3$, and 6.0 M NH_3.

The student made these observations:

(1) Solution II is blue.

(2) Solution II reacts with solution III to form a blue precipitate that dissolves in excess III.

(3) Solution II reacts with solution IV to form a white precipitate.

(4) Solution I does not react with solution II.

Identify the solution in each tube.

	$AgNO_3$	$CuCl_2$	$Al(NO_3)_3$	$NH_3(aq)$
A	IV	II	I	III
B	I	IV	II	III
C	IV	II	III	I
D	I	II	III	IV

☐ A

☐ B

☐ C

☐ D

23. Which of the following changes are involved in burning a candle?

☐ An endothermic chemical change and an exothermic phase change

☐ An endothermic chemical change and an endothermic phase change

☐ An exothermic chemical change and an endothermic phase change

☐ An exothermic chemical change and an exothermic phase change

24. Consider an ideal gas with volume of V at a particular temperature and pressure. If the Kelvin temperature is doubled and the pressure is quadrupled, the new volume of the gas, expressed in liters, is

- ☐ V/2
- ☐ V
- ☐ 2V
- ☐ 4V

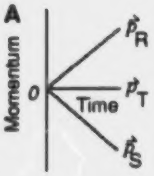
25. If two different masses have the same kinetic energy, their momenta are

- ☐ proportional to their masses.
- ☐ proportional to the squares of their masses.
- ☐ proportional to the square roots of their masses.
- ☐ inversely proportional to the squares of their masses.
- ☐ inversely proportional to the square roots of their masses.

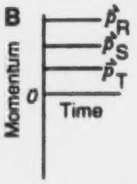
26. Two stationary objects R and S, resting on a smooth surface, are released at the same time and move toward each other under the influence of the force of gravitational attraction between them. At any instant during the motion, R has twice the speed of S.

Which one of the following graphs represents the individual momentum of R($\vec{p}_R$) and S($\vec{p}_S$) and the total momentum of the system ($\vec{p}_T$) as a function of time after release?

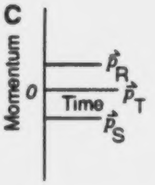
A



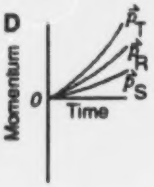
B



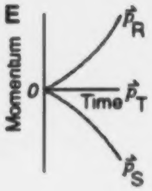
C



D



E

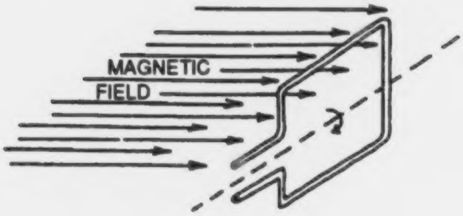


- ☐ A
- ☐ B
- ☐ C
- ☐ D
- ☐ E

27. Which of the following factors does NOT affect the strength of an electromagnet?

- ☐ The direction of the windings
- ☐ The diameter of the core
- ☐ The number of turns in the coil
- ☐ The permeability of the core
- ☐ The resistance of the coil wire

28. The loop shown in the diagram below rotates about an axis which is perpendicular to a constant uniform magnetic field. If only the direction of the field is reversed, the magnitude of the maximum induced potential difference will



☐ decrease.

☐ increase.

☐ remain the same.

29. A Geiger counter operates on the principle that

☐ the ionization and deionization of certain crystals is accompanied by the emission of light.

☐ an electrically charged conductor will lose its charge in the presence of radioactivity.

☐ vapors condense more easily on charged particles than on uncharged particles.

☐ beta particles deionize a gas through which they pass.

☐ a neutral conductor becomes charged in the presence of radioactivity.

30. A 30 kg carton of books is carried up a flight of stairs 4.0 m high. ($g = 10$ N/kg)

If the time required is 1.0 min, the power required is approximately

☐ 2.0×10 W

☐ 1.2×10^2 W

☐ 4.5×10^2 W

☐ 1.0×10^3 W

☐ 4.5×10^3 W

31. From the choices below, select the type of wave or ray which has the highest energy.

☐ radio waves

☐ infrared rays

☐ visible light

☐ X-rays

☐ ultraviolet waves

32. Monochromatic light, traveling in a vacuum, strikes the surface of a liquid at an angle of incidence of 45°. The angle of refraction is 30°.

What happens if the same light, traveling in the liquid, strikes the surface of the liquid at an angle of incidence of 45°? You may find the following angles and sines in the table below useful.

Angle	Sine
30	0.5000
45	0.7071
60	0.8660
90	1.0000

☐ The light leaves the liquid at an angle of refraction of 30°.

☐ The light leaves the liquid at an angle of refraction of less than 30°.

☐ The light leaves the liquid at an angle of refraction of about 90°.

☐ The light stays in the liquid at an angle of reflection of 45°.

☐ The light disappears completely.

Form 3
Easy

1. The length of Earth's year is about 365 days. This length is determined by the time it takes for

☐ the Sun to revolve around Earth once.

☐ the Moon to revolve around Earth once.

☐ Earth to rotate on its axis once.

☐ Earth to revolve around the Sun once.

2. From the relationships below, select the one that illustrates a celestial body and its satellite.

☐ Sun and Earth

☐ Earth and Venus

☐ Mars and Polaris

☐ Pluto and Saturn

☐ Mercury and Jupiter

3. In the winter it tends to be warmer on a cloudy night than on a clear night. This is because

☐ it is about to snow.

☐ of the Newton principle.

☐ the clouds are warmer.

☐ of the greenhouse effect.

4. In New York State, the maximum total daily insolation occurs during June. Which statement best explains why the maximum annual temperature is usually observed about a month later, in July?

☐ The Earth is closer to the Sun in June than it is in July.

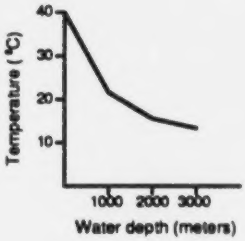
☐ The Earth is farther from the Sun in June than it is in July.

☐ New York State receives more energy than it loses during most of July.

☐ New York State loses more energy than it receives during most of July.

5. According to the graph below, at 4,000 m, the temperature will be less than 10°C.

This statement is



☐ a prediction.

☐ a calculation.

☐ an observation.

☐ a fact.

6. If the distance between crests of incoming waves is 200 m and the time between each passing crest is 20 sec, how fast are these waves traveling?

Wave velocity = wave length/period

☐ 0.1 m/sec

☐ 5 m/sec

☐ 10 m/sec

☐ 4,000 m/sec

7. When waste chemicals are buried in the ground, the most likely danger to people is that the chemicals may

☐ speed up weathering of the bedrock.

☐ enter the water supply.

☐ change the climate in the area.

☐ explode and cause an earthquake.

8. Which of the following is evidence that the Earth's crust has undergone great changes during its history?

☐ The constant pounding of ocean waves on the coastlines

☐ The occurrence of a large number of earthquakes each year

☐ The continued flowing of vast amounts of river water into the sea

☐ The presence of marine fossils in the rocks making up high mountains

☐ The temperature changes measured at different locations around the world

9. The table in which all of the chemical elements are arranged to show many relationships among them is called the

☐ activity table.

☐ periodic table.

☐ table of acid strengths.

☐ table of electronegatives.

☐ table of oxidation potentials.

10. The nucleus of an atom contains

☐ only electrons.

☐ only neutrons.

☐ electrons and protons.

☐ protons and neutrons.

11. Which substance reacts with water vapor in the atmosphere to produce acid rain?

☐ SO_3

☐ PbO

☐ NH_3

☐ $NaCl$

12. Why does an aqueous solution of NH_4Cl have a pH less than 7?

☐ The Cl^- ions reacted with water to produce OH^- ions.

☐ The NH_4^+ ions reacted with water to produce OH^- ions.

☐ The Cl^- ions reacted with water to produce H_3O^+ ions.

☐ The NH_4^+ ions reacted with water to produce H_3O^+ ions.

13. Mass is a property of

☐ heat from a stove.

☐ light from the Sun.

☐ air in a balloon.

☐ sound in a room.

14. In a laboratory exercise to determine the density of a substance, a student found the mass of the substance to be 6.00 grams and the volume to be 2.0 milliliters. Expressed to the correct number of significant figures, the density of the substance is

☐ 3.000 g/mL

☐ 3.00 g/mL

☐ 3.0 g/mL

☐ 3 g/mL

15. The solid, liquid, and gaseous states of water differ in which of the following ways?

☐ the number of protons per molecule

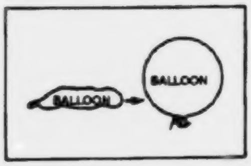
☐ the number of electrons per molecule

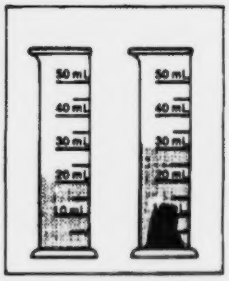
☐ the net charge on the individual molecules

☐ the number of neutrons per individual molecule

☐ the average speed with which the molecules are moving

16. What do the diagrams below show about matter?





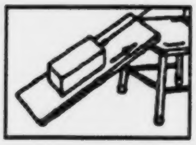
☐ It is made up of elements.

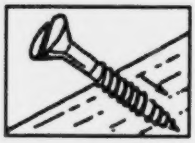
☐ It takes up space.

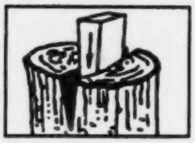
☐ It is a solid.

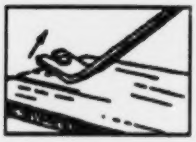
☐ It floats.

17. Which diagram shows a lever in use?

A


B


C


D


☐ A

☐ B

☐ C

☐ D

18. The amount of work per unit of time is called

☐ force.

☐ power.

☐ kinetic energy.

☐ potential energy.

19. Consider the following statements:

I. A positively charged sphere will repel a negatively charged sphere.

II. A negatively charged sphere will attract a negatively charged sphere.

III. A positively charged sphere will attract a negatively charged sphere.

IV. A positively charged sphere will attract a neutral sphere.

Which of the above statements are correct?

☐ I and II only.

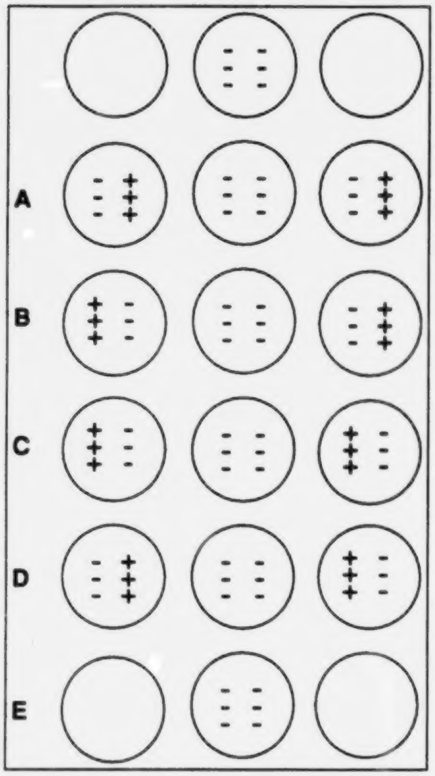
☐ I and IV only.

☐ III and IV only.

☐ I, II and III only.

☐ I, III and IV only.

20. As shown in the diagram below, a negatively charged conducting sphere is placed between (but does not touch) two fixed neutral conducting spheres. Which diagram best represents the distribution of charge on the spheres after equilibrium has been established?



☐ A

☐ B

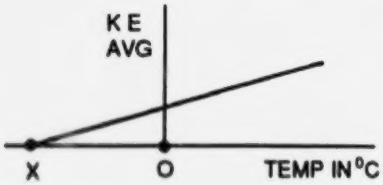
☐ C

☐ D

☐ E

21. The graph below represents the relationship between the temperature of a gas and the average kinetic energy (KE) of the molecules of the gas.

The temperature represented at point X is approximately



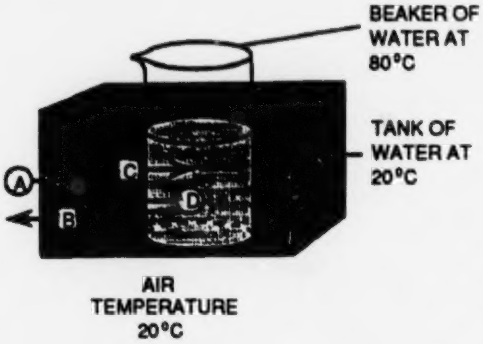
☐ 273°C

☐ 0°C

☐ −273°C

☐ −373°C

22. A beaker of hot water is placed in a tank full of water at room temperature. Which arrow shows the direction of greatest heat flow?


BEAKER OF WATER AT 80°C
TANK OF WATER AT 20°C
A
B
C
D
AIR TEMPERATURE 20°C

☐ A

☐ B

☐ C

☐ D

23. When one end of the water wave changes speed, the wave

☐ stays straight.
☐ bends.
☐ turns around.
☐ stops.

24. Light is sometimes described as a wave motion because

☐ Einstein, a prominent scientist, said that light is a wave motion.
☐ light waves have been observed directly by scientists.
☐ light behaves at all times as a wave.
☐ many of the properties of light can be explained using a wave model.
☐ all of the properties of light can be explained using a wave model.

25. A paramecium on a slide can usually be found more easily by using the low-power objective rather than the high-power objective, because with low power

☐ the field is not as bright.
☐ the organism can be seen in greater detail.
☐ smaller organisms can be seen.
☐ a larger part of the slide can be seen.

26. Which of the following is often considered to be the simplest biological unit of structure?

☐ the cell
☐ the organ
☐ the tissue
☐ the organism

27. When muscles are viewed through the light microscope, the striations that appear are caused by the presence of

☐ alternating fat and carbohydrate layers.
☐ protein filaments.
☐ blood vessels.
☐ nerve cells.

28. Some plants have shallow roots. How might they be an advantage for the plant?

☐ They give good support against strong winds.
☐ They soak up water quickly for the plant.
☐ They are less likely to be damaged by burrowing animals.
☐ They prevent the plant from being washed away by heavy rains.

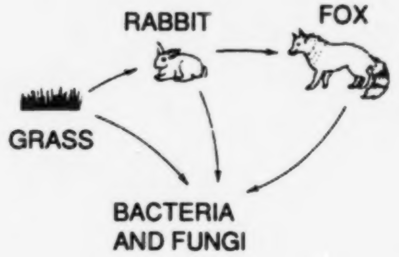
29. When studying the effect of light on seed germination, which condition should be changed?

☐ temperature
☐ moisture
☐ light
☐ humidity

30. A man whose blood type is OA marries a woman whose blood type is OB. Their offspring could NOT have which of the following blood types?

☐ AA
☐ AB
☐ OA
☐ OB
☐ OO

31. The diagram shows a simple food web. The action of the bacteria in this food web results in



☐ energy for living things.

☐ decomposition of plants and animals.

☐ oxygen in the environment.

☐ food for plants and animals.

32. A pyramid is often used to show the relationship between organisms at different levels in a food chain or web. Which two factors does a pyramid illustrate?

☐ food and water

☐ energy and food

☐ nutrients and matter (or biomass)

☐ matter (or biomass) and energy

Form 3
Intermediate

1. The "Doppler shift" indicates the

- ☐ direction of a star's movement.
- ☐ occurrence of a nova.
- ☐ presence of an unknown substance within a star.
- ☐ relative mass of a star.

2. If three identical 100 watt light bulbs were placed at distances of 5 meters, 50 meters, and 500 meters from an observer, each would seem to have a different brightness. Applied to astronomy, this analogy best explains differences in

- ☐ red shift.
- ☐ star composition.
- ☐ parallax.
- ☐ apparent magnitude.

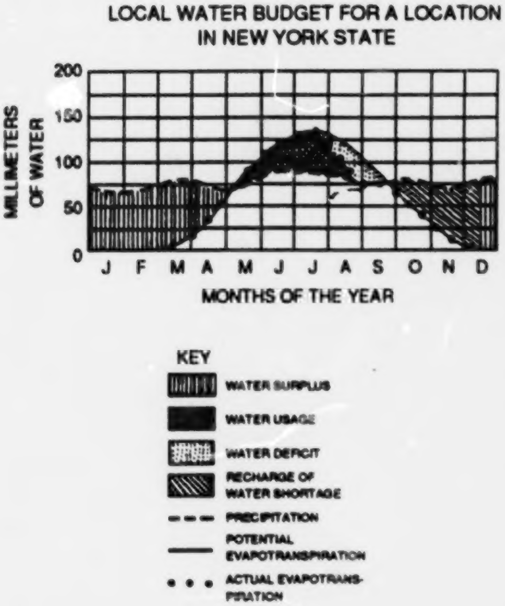
3. Which gas occurs in the atmosphere in the greatest amount?

- ☐ oxygen
- ☐ nitrogen
- ☐ argon
- ☐ carbon dioxide

4. The barometric pressure is slowly falling, the wind speed has increased and stratus clouds appear. Which is the best prediction based on the information?

- ☐ A warm front will move through.
- ☐ A cold front will move through.
- ☐ Tornadoes will likely occur soon.
- ☐ The skies will clear in a few hours.

5. In the graph below, the actual evapotranspiration during the year is



LOCAL WATER BUDGET FOR A LOCATION IN NEW YORK STATE

- ☐ always greater than potential evapotranspiration.
- ☐ sometimes greater than potential evapotranspiration.
- ☐ never greater than potential evapotranspiration.

6. Diagram I represents a map view of a stream with reference points A through E within the stream bed. Diagram II represents a geologic cross-section of the area over which the stream flows. (Assume that the volume of the stream is constant.)

At which point would the stream's velocity most likely be greatest?

DIAGRAM I: Top View

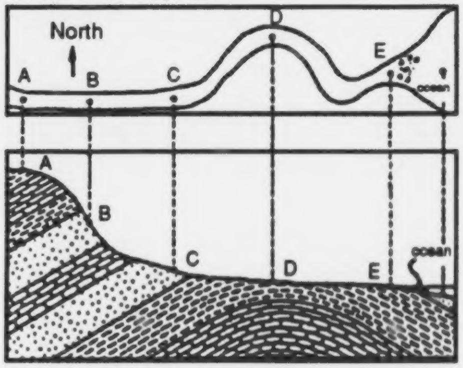


DIAGRAM II: Cross-sectional View

Key:
- ▨ Sand, Silt
- ▤ Shale
- ▦ Limestone
- ▒ Sandstone

NOT TO SCALE

☐ A

☐ B

☐ C

☐ D

☐ E

7. Two different rocks contain the same minerals. Physical factors present during their formation that caused the rocks to be different include

☐ temperature, pressure, and magnesium supply.

☐ temperature, weathering, and cleavage.

☐ time, temperature, and sunlight.

☐ time, pressure, and temperature.

8. Which of the following is evidence that the Earth's crust has undergone great changes during its history?

☐ The constant pounding of ocean waves on the coastlines

☐ The occurrence of a large number of earthquakes each year

☐ The continued flowing of vast amounts of river water into the sea

☐ The presence of marine fossils in the rocks making up high mountains

☐ The temperature changes measured at different locations around the world

9. The original format of the Periodic Table, as described by Mendeleev, was based on the arrangement of the elements

☐ according to chemical properties.

☐ in order of increasing density.

☐ in order of increasing number of neutrons.

☐ with reference to nuclear stability.

10. The Periodic Law states that the chemical properties of elements are periodic functions of their

☐ atomic masses.

☐ number of neutrons.

☐ atomic numbers.

☐ isotopic masses.

11. The ion responsible for the acidic properties of any aqueous acid is

☐ the hydronium ion.

☐ the hydroxide ion.

☐ the negative ion.

☐ the oxide ion.

12. Why does an aqueous solution of NH_4Cl have a pH less than 7?

☐ The Cl^- ions reacted with water to produce OH^- ions.

☐ The NH_4^+ ions reacted with water to produce OH^- ions.

☐ The Cl^- ions reacted with water to produce H_3O^+ ions.

☐ The NH_4^+ ions reacted with water to produce H_3O^+ ions.

13. Consider the reaction mechanism in the table below. The equation for the overall reaction is

$A + B \rightarrow C$	slow
$C + 2A \rightarrow D + E$	fast
$E \rightarrow F$	fast

☐ $A + B \rightarrow F$

☐ $3A + B \rightarrow D + F$

☐ $2A + C \rightarrow D + F$

☐ $3A + B + C + E \rightarrow C + D + E + F$

14. When one mole of $KClO_3$ (potassium chlorate) decomposes to form KCl (potassium chloride) and O_2 (oxygen) as its only products, the number of moles of O_2 produced is

☐ 1

☐ 3

☐ 2

☐ 1.5

15. Above 0°C, ice changes spontaneously to water according to the following equation:

$H_2O(s) + \text{heat} \rightarrow H_2O(\ell)$.

The changes in $H_2O(s)$ involve

☐ an absorption of heat and a decrease in entropy.

☐ a release of heat and a decrease in entropy.

☐ an absorption of heat and an increase in entropy.

☐ a release of heat and an increase in entropy.

16. The degree of ionization of a solution refers to

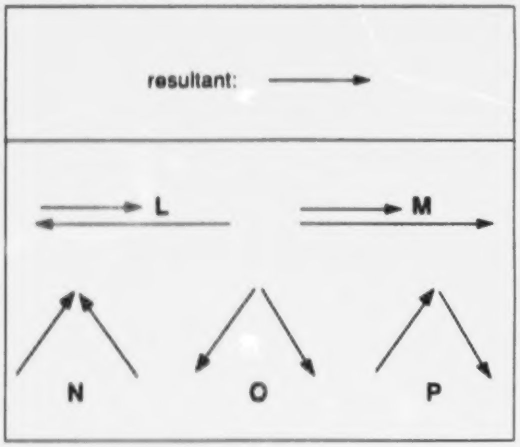
☐ the temperature at which the solution ionizes.

☐ the fraction of molecules ionized in the solution.

☐ the quantity of free electrons present in the solution.

☐ the fraction of unionized molecules in the solution.

17. Which two vectors shown below equal the resultant?



☐ L

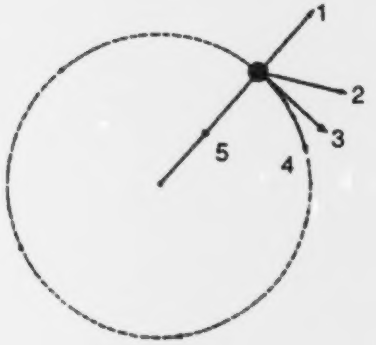
☐ M

☐ N

☐ O

☐ P

18. A heavy ball is attached to a string and swung in a circle. The string breaks. Which arrow in the diagram below best represents the direction in which the ball will travel just after the string breaks?



Path of ball

☐ arrow 1
☐ arrow 2
☐ arrow 3
☐ arrow 4
☐ arrow 5

19. The electric field between charged parallel plates is

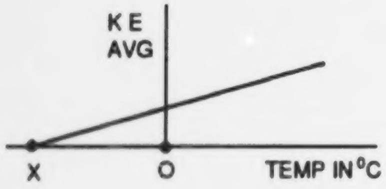
☐ uniform.
☐ strongest near each plate.
☐ dependent on the area of the plates.
☐ strongest midway between the plates.

20. A circuit contains two 6 ohm resistors in parallel, these are in series with a 6 ohm resistor. The total voltage applied to the circuit is 9 volts. The total current is

☐ 0.5 A
☐ 1 A
☐ 4.5 A
☐ 9 A

21. The graph below represents the relationship between the temperature of a gas and the average kinetic energy (KE) of the molecules of the gas.

The temperature represented at point X is approximately



☐ 273°C
☐ 0°C
☐ −273°C
☐ −373°C

22. A student uses a force of 2 N to lift a mass a distance of 3 meters. How much work has the student done on the mass?

☐ 6 N m
☐ 3 m
☐ 2 N m
☐ 5 N m
☐ 2 N

23. Electromagnetic radiation is generated by

☐ electrons moving at constant velocity.
☐ accelerating neutral atoms.
☐ accelerating charges.
☐ electrons in stable atomic orbits.
☐ accelerating neutrons.

24. Radio waves are MOST like waves and LEAST like particles in that they

☐ can exert pressure.
☐ carry energy from one place to another.
☐ can travel through the vacuum of space.
☐ diffract around objects such as trees or houses.

25. Cell organelles may be separated according to their densities by the use of

☐ a compound light microscope.
☐ an ultracentrifuge.
☐ an electron microscope.
☐ a microdissection instrument.

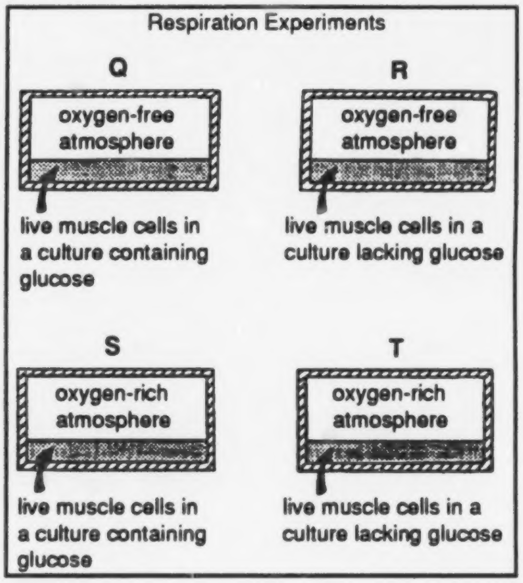
26. A system in which potassium ions moved from a solution containing a low concentration of ions into a cell with a higher concentration of the same ions would be an example of

☐ osmosis.
☐ passive transport.
☐ active transport.
☐ diffusion.
☐ pinocytosis.

27. When muscles are viewed through the light microscope, the striations that appear are caused by the presence of

☐ alternating fat and carbohydrate layers.
☐ protein filaments.
☐ blood vessels.
☐ nerve cells.

28. Which experiment in the graph below would produce the GREATEST amount of CO_2?


Respiration Experiments
Q
oxygen-free atmosphere
live muscle cells in a culture containing glucose
R
oxygen-free atmosphere
live muscle cells in a culture lacking glucose
S
oxygen-rich atmosphere
live muscle cells in a culture containing glucose
T
oxygen-rich atmosphere
live muscle cells in a culture lacking glucose

☐ Q
☐ R
☐ S
☐ T

29. Frequent injections of insulin are often required in order to treat the disorder known as diabetes. Insulin can now be produced in the laboratory through the use of

☐ vegetative propagation.
☐ artificial selection.
☐ sexual reproduction.
☐ recombinant DNA.

30. Red is dominant to white. How could you find out if a red-flowered plant was homozygous or heterozygous? By crossing the red-flowered plant with:

I. a pure-breeding red-flowered plant
II. a heterozygous red-flowered plant
III. itself, by self-fertilization
IV. a homozygous white-flowered plant

☐ II, III and IV only.
☐ III only.
☐ IV only.
☐ I, II and III only.
☐ III and IV only.

31. Studies in Manchester, England, showed that the proportion of dark moths in the peppered moth population increased in the 19th century as smoke from factories made tree bark darker. This evidence indicated

☐ that light and dark moths differ in their ability to survive on light and dark backgrounds.
☐ that dominant genes will eventually replace their recessive alleles.
☐ support for Hardy-Weinberg law.
☐ that dark moths evolved from white moths.
☐ that individual moths can change because of environmental pressures.

32. A pyramid is often used to show the relationship between organisms at different levels in a food chain or web. Which two factors does a pyramid illustrate?

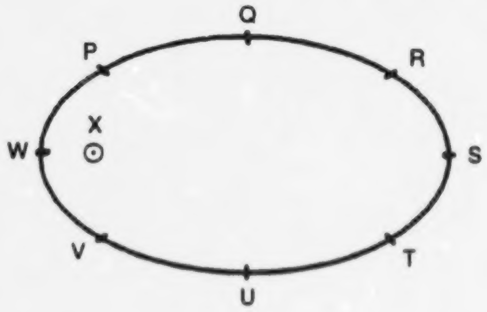
☐ food and water
☐ energy and food
☐ nutrients and matter (or biomass)
☐ matter (or biomass) and energy

Form 3
Difficult

1. Most astronomers classify stars according to

☐ their size and shape.
☐ the elements they contain.
☐ their color and temperature.
☐ their distance from Earth.

2. The diagram below illustrates the path of an imaginary planet traveling in an elliptical orbit about a star X. The letters P to W represent positions of the planet in its orbit. At which point does the planet have the greatest speed?

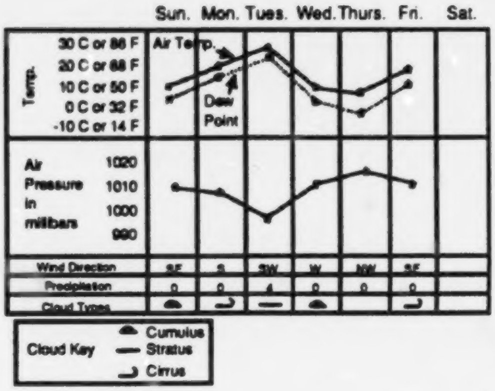


☐ P
☐ U
☐ S
☐ W
☐ It has the same speed at all points.

3. Which gas occurs in the atmosphere in the greatest amount?

☐ oxygen
☐ nitrogen
☐ argon
☐ carbon dioxide

4. According to the chart below, on which day was there the greatest chance of precipitation?

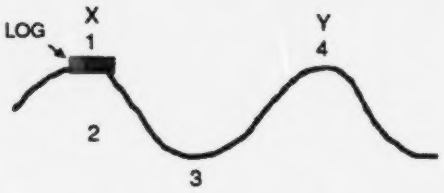


☐ Monday
☐ Tuesday
☐ Wednesday
☐ Thursday

5. Salinity of ocean waters is measured as

☐ the ratio of the density of ocean water to that of distilled water.
☐ the concentration of sodium in ocean water.
☐ the number of grams of dissolved salts per kilogram of ocean water.
☐ the difference in the freezing point of ocean water and distilled water.

6. The diagram below represents a portion of the ocean surface far from shore. After the wave moves from position X to position Y, the log would be in position



☐ 1

☐ 2

☐ 3

☐ 4

7. Fossil fuels most likely were formed over millions of years from the

☐ rocks found on mountaintops.

☐ uranium found deep within Earth.

☐ glaciers which covered Earth.

☐ remains of dead plants and animals.

8. An unconformity in rock layers results when

☐ a revolution occurs.

☐ a long period of time passes before the next layer or rock is formed.

☐ magma intrudes between the layers.

☐ layers of different thicknesses are formed.

9. In a mass spectrograph, the ions which are likely to undergo the greatest deflection have

☐ greatest charge and largest mass.

☐ greatest charge and smallest mass.

☐ smallest charge and largest mass.

☐ smallest charge and smallest mass.

10. The Periodic Law states that the chemical properties of elements are periodic functions of their

☐ atomic masses.

☐ number of neutrons.

☐ atomic numbers.

☐ isotopic masses.

11. "When a particular reaction can be expressed as the sum of other reactions, the heat of the reaction is the algebraic sum of the heats of these reactions." This statement is referred to as

☐ Hess' law.

☐ Nobel's law.

☐ Boyle's Law.

☐ Priestley's Law.

12. Which of the following would NOT be produced by the addition of hydrochloric acid (HCl) to sodium sulfite (Na_2SO_3)?

☐ Cl_2

☐ $NaCl$

☐ H_2O

☐ SO_2

13. Consider the reaction mechanism in the table below. The equation for the overall reaction is

$A + B \rightarrow C$	slow
$C + 2A \rightarrow D + E$	fast
$E \rightarrow F$	fast

☐ $A + B \rightarrow F$

☐ $3A + B \rightarrow D + F$

☐ $2A + C \rightarrow D + F$

☐ $3A + B + C + E \rightarrow C + D + E + F$

14. In the balanced equation

$6I^-(aq) + 2MnO_4^-(aq) + 4H_2O(l) \rightarrow 3I_2(s) + 2MnO_2(s) + 8OH^-(aq)$,

the number of moles of electrons transferred is

☐ 2 mol

☐ 3 mol

☐ 6 mol

☐ 7 mol

15. What type of substance could melt at −7.2°C and not conduct electricity in either the solid or liquid state?

☐ ionic crystal

☐ metallic crystal

☐ covalent network crystal

☐ molecular crystal

16. A transparent crystalline substance is found to be rather soft and to have a low melting point. The crystal is most probably an example of a(n)

☐ molecular solid.

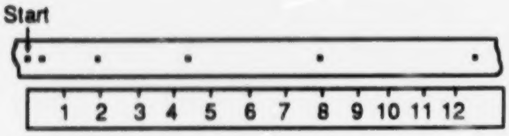
☐ ionic solid.

☐ network solid.

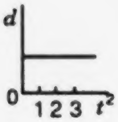
☐ metallic solid.

17. The tape from a laboratory experiment using a recording timer has the appearance shown below. A ruler graduated in cm is shown below the tape.

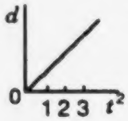
Which one of the graphs shown below could be the distance v. $(time)^2$ graph?



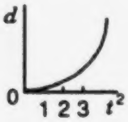
L



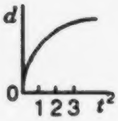
M



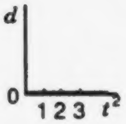
N



O



P



☐ L

☐ M

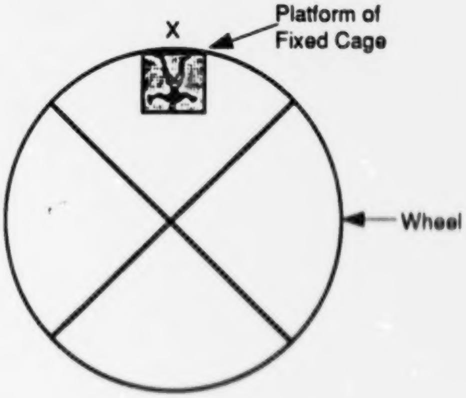
☐ N

☐ O

☐ P

18. A giant wheel has a diameter of 40 m. The wheel is fitted with a fixed cage and platform on which a man of mass m can stand. The wheel is rotated vertically at such a speed that the force exerted by the man on the platform when the cage and platform are at position X is equal in magnitude to the force of gravity on the man. (g = 10 m/s^2)

What is the net force on the man as the platform passes point X?



☐ zero

☐ mg down

☐ mg up

☐ 2 mg down

☐ 2 mg up

19. A neutral object

☐ is electrically attracted to a negative object.

☐ has zero protons.

☐ is composed only of neutrons.

☐ has zero electrons.

☐ is electrically attracted to a neutral object.

20. A circuit contains two 6 ohm resistors in parallel, these are in series with a 6 ohm resistor. The total voltage applied to the circuit is 9 volts. The total current is

☐ 0.5 A

☐ 1 A

☐ 4.5 A

☐ 9 A

21. A sensitive mercury-in-glass thermometer at room temperature is immersed in boiling water. The mercury level first drops slightly and then rises. Why does the drop occur?

☐ The specific heat of glass is greater than that of mercury.

☐ The coefficient of expansion is greater for glass than for mercury.

☐ The glass expands before the mercury does.

☐ At room temperature, mercury has a negative coefficient of expansion like that of water from 0 °C to 4 °C.

☐ The surface tension of mercury increases with temperature.

22. A 1500 watt electric water heater can heat 2 kg of water from 15 °C to 35 °C in 140 seconds. Find the efficiency of the heater. Assume that 4200 joules of heat energy are needed to increase the temperature of 1 kg of water by 1 °C.

☐ 20 per cent

☐ 40 per cent

☐ 80 per cent

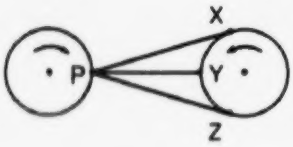
☐ 100 per cent

☐ 125 per cent

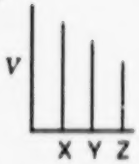
23. Microwaves rather than low frequency radiowaves are used in cooking because they have

- ☐ shorter wavelength with higher energy.
- ☐ lower frequency with higher energy.
- ☐ longer wavelength with lower energy.
- ☐ higher frequency with lower energy.

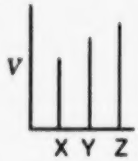
24. Two discs are rotating in opposite directions. The graph that BEST illustrates the relative speeds of the light that reaches point P from points X, Y, and Z is



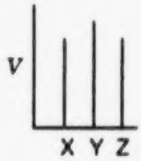
W



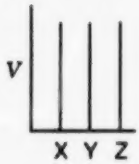
X



Y



Z

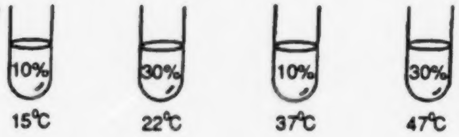


- ☐ W
- ☐ X
- ☐ Y
- ☐ Z

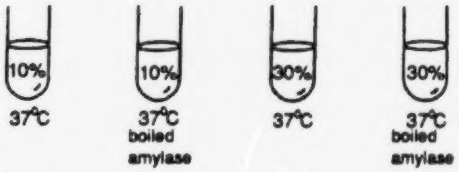
25. Four experiments, labeled W, X, Y, and Z, were designed to test the effect of temperature on the activity of enzyme amylase. The four test tubes in each experiment contained 5 mL of a starch suspension at the concentration indicated as well as 1 mL of amylase suspension at a constant concentration. All test tubes and their contents were incubated at the temperatures indicated for 1 h.

Which experimental design was MOST appropriate for gathering data about the problem under investigation?

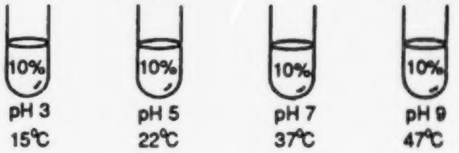
W


10%
15°C
30%
22°C
10%
37°C
30%
47°C

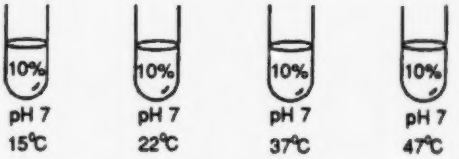
X


10%
37°C
10%
37°C
boiled
amylase
30%
37°C
30%
37°C
boiled
amylase

Y


10%
pH 3
15°C
10%
pH 5
22°C
10%
pH 7
37°C
10%
pH 9
47°C

Z


10%
pH 7
15°C
10%
pH 7
22°C
10%
pH 7
37°C
10%
pH 7
47°C

- ☐ W
- ☐ X
- ☐ Y
- ☐ Z

26. If the membrane structure inside a chloroplast breaks down, the part of photosynthesis most likely to be affected would be the

☐ production of oxygen.

☐ production of ATP.

☐ absorption of light.

☐ oxidation of chlorophyll.

☐ activation of accessory pigments.

27. The lymphatic and venous transport systems both

☐ produce types of phagocytic white blood cells.

☐ return waste materials directly to the kidneys.

☐ rely on skeletal muscle contraction to move fluids.

☐ carry large numbers of oxygen-poor red blood cells.

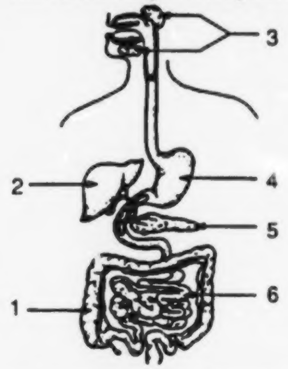
28. The region labeled 4 functions MAINLY in the digestion of which of the unknown substances tested below?

Results from Indicator Tests of Unknown Substances

Unknown Substance(s)	Test				
	Benedict's	Iodine	Sudan IV	Translucence	Biuret
I	+	-	-	-	-
II	-	+	-	-	-
III	-	-	-	-	+
IV	-	-	+	+	-

Note: + indicates a positive result - indicates a negative result

The Human Digestive System



☐ I

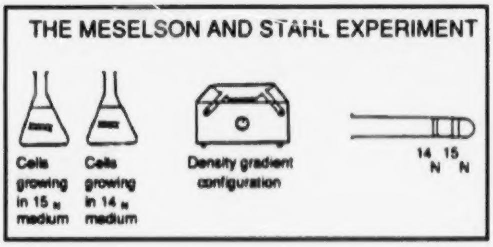
☐ II

☐ III

☐ IV

29. The figure below illustrates the apparatus and technique used by Meselson and Stahl to separate DNA molecules of two different densities. The technique, which made use of isotopes of nitrogen, is called density gradient centrifugation.

^{15}N DNA migrates lower in a centrifuge tube than ^{14}N DNA because


THE MESELSON AND STAHL EXPERIMENT

Cells growing in 15 N medium
Cells growing in 14 N medium
Density gradient configuration
14 N
15 N

☐ it reacts with the cesium chloride in the centrifuge tube.

☐ it is less dense than ^{14}N DNA.

☐ it is radioactive, whereas ^{14}N DNA is not.

☐ it is more dense than ^{14}N DNA.

☐ it becomes radioactive during the experiment.

30. Red is dominant to white. How could you find out if a red-flowered plant was homozygous or heterozygous? By crossing the red-flowered plant with:

I. a pure-breeding red-flowered plant

II. a heterozygous red-flowered plant

III. itself, by self-fertilization

IV. a homozygous white-flowered plant

☐ II, III and IV only.

☐ III only.

☐ IV only.

☐ I, II and III only.

☐ III and IV only.

31. The following are statements which might relate to the growth of the human population in the past two thousand years:

I. The human population has grown both arithmetically and exponentially.

II. Up until this century, disease has slowed the growth of the population.

III. The increase in the world population today is largely due to the increasing birth rates.

IV. Crop yields basically increase arithmetically while the human population increases exponentially.

V. The age distribution of a population does not affect its growth.

Which of the above statements are true?

☐ II and IV only.

☐ I, III, and V only.

☐ II, III, and V only.

☐ II, IV, and V only.

☐ I, III, and IV only.

32. Which one of the following is NOT involved in speciation?

- ☐ variability in the environment
- ☐ a homogeneous environment
- ☐ geographical isolation
- ☐ gamete incompatibility
- ☐ different breeding seasons

Form 3
More Difficult

1. Most astronomers classify stars according to

☐ their size and shape.

☐ the elements they contain.

☐ their color and temperature.

☐ their distance from Earth.

2. Earth's magnetic field most likely occurs because

☐ Earth's molten core is rotating.

☐ most of Earth's iron ore is located near the North Pole.

☐ Earth's equator is tilted with respect to its orbital plane.

☐ a completely solid, rotating planet always has a magnetic field.

3. What gas is most effective in reducing heat loss from the earth by absorbing re-radiated heat energy?

☐ argon

☐ oxygen

☐ carbon dioxide

☐ nitrogen

4. In which air sample will condensation most likely occur?

Air Temperature = -2^0 C Dewpoint = -4^0 C Clean Filtered Air	Air Temperature = 10^0 C Dewpoint = 7^0 C Air Containing Tiny Particles
A	**C**
Air Temperature = 5^0 C Dewpoint = 5^0 C Air Containing Tiny Particles	Air Temperature = 20^0 C Dewpoint = 20^0 C Clean Filtered Air
B	**D**

☐ A

☐ B

☐ C

☐ D

5. The State Game Commission wishes to estimate the number of bass in a state-owned lake. In preparation for using the "recapture" method for this purpose, it releases 500 legal-size bass with plastic tags affixed to their tail fins. The Commission then requires people who are licensed to fish in the lake to report the number of legal-size bass caught during the fishing season, and also to send in any tags that were found on the fish.

Suppose that 2,654 fish were reported caught, and that 108 tags were returned. Which of the following calculations will estimate the total number (T) of legal-size bass in the lake before the study?

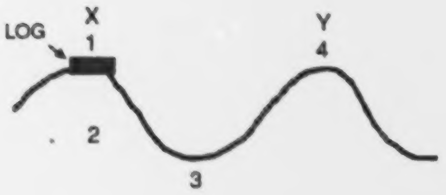
☐ $T = \frac{108 \times 2{,}654}{500}$

☐ $T = \frac{500 \times 2{,}654}{108}$

☐ $T = \frac{500 \times (2{,}654 - 108)}{108}$

☐ $T = \frac{500 \times 2{,}654}{108} - 500$

6. The diagram below represents a portion of the ocean surface far from shore. After the wave moves from position X to position Y, the log would be in position



☐ 1
☐ 2
☐ 3
☐ 4

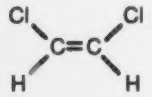
7. Compared to the average thickness of the oceanic crust, the average thickness of the continental crust is

☐ less.
☐ greater.
☐ the same.

8. Which observation provides the strongest evidence for the inference that convection cells exist within the Earth's mantle?

☐ The sea level has varied in the past.
☐ Marine fossils are found at elevations high above sea level.
☐ Displaced rock strata are usually accompanied by earthquakes and volcanoes.
☐ Heat-flow readings vary at different locations in the Earth's crust.

9. The correct name for the compound below is



☐ cis-dichloroethene.
☐ trans-dichloroethene.
☐ 1,2-dichloroethane.
☐ 1,1-dichloroethene.

10. According to the molecular orbital theory, what is the bond order and the number of unpaired electrons, respectively, in the peroxide ion, O_2^{2-}?

☐ 1, 0
☐ 1, 2
☐ 1.5, 0
☐ 3, 0

11. A sample of natural gas consists of 8.0 mol methane and 2.0 mol ethane. Which of the following statements is true?

☐ When ethane burns, it releases more heat per mole than methane.
☐ For combustion, ethane requires less oxygen per mole than methane.
☐ For combustion, the heat released per mole of mixture will be equivalent to that of methane.
☐ For combustion, the heat released per mole of mixture will be less than that of methane but more than that of ethane.

12. Four reducing agents listed in order of decreasing strength are W, Z, Y, and X.

Four statements about the reaction between the reducing agents and their respective oxidizing agents are:

I. $W(s) + X^{2+}(aq) \rightarrow W^{2+}(aq) + X(s)$

II. $Y(s) + X^{2+}(aq) \rightarrow Y^{2+}(aq) + X(s)$

III. $W(s) + Z^{2+}(aq) \rightarrow$ no reaction

IV. $Y(s) + Z^{2+}(aq) \rightarrow Y^{2+}(aq) + Z(s)$

The statement(s) inconsistent with the correct order of reducing agents is(are)

☐ IV only.

☐ III only.

☐ I and II.

☐ III and IV.

13. In a calorimetric experiment,

I. the amount of heat involved is dependent on the mass of the reactant used.

II. the amount of heat involved is dependent on the temperature change occurring in the system.

III. the heat involved is completely transferred to the calorimeter water.

IV. stirring speeds up the heat transfer so thermal equilibrium is reached quicker.

Which statement(s) is(are) an assumption?

☐ IV only.

☐ III only.

☐ I and II only.

☐ I, II, III, and IV.

14. Consider the initial rate data for a reaction of

$H_2PO_2^-$ and OH^-.

What is the rate equation for this reaction?

Trial	$[H_2PO_2^-]$	$[OH^-]$	Rate($mol \cdot L^{-1} \cdot s^{-1}$)
1	0.35	0.35	1.5×10^{-4}
2	0.69	0.21	1.0×10^{-4}
3	0.35	0.21	5.2×10^{-5}

☐ Rate = $k[H_2PO_2^-][OH^-]$

☐ Rate = $k[H_2PO_2^-]^2[OH^-]$

☐ Rate = $k[H_2PO_2^-][OH^-]^2$

☐ Rate = $k[H_2PO_2^-]^2[OH^-]^2$

15. What type of substance could melt at −7.2°C and not conduct electricity in either the solid or liquid state?

☐ ionic crystal

☐ metallic crystal

☐ covalent network crystal

☐ molecular crystal

16. Consider the initial and final data for an ideal gas in the table below. Which expression gives the final volume, V_2, in liters?

	Initial	Final
Pressure	3 atm	5 atm
Volume	2 L	? L
Temperature	300 K	400 K

☐ $2 \times \frac{3}{5} \times \frac{300}{400}$

☐ $2 \times \frac{5}{3} \times \frac{400}{300}$

☐ $2 \times \frac{3}{5} \times \frac{400}{300}$

☐ $2 \times \frac{5}{3} \times \frac{300}{400}$

17. Multiplying physical quantities together can yield a new physical quantity. Consider the following products:

I. acceleration times time

II. mass times velocity

III. mass times acceleration

IV. mass times force

V. mass times time

Assuming that all the products are new physical quantities, which of the above new physical quantities is/are scalar?

☐ II only.

☐ V only.

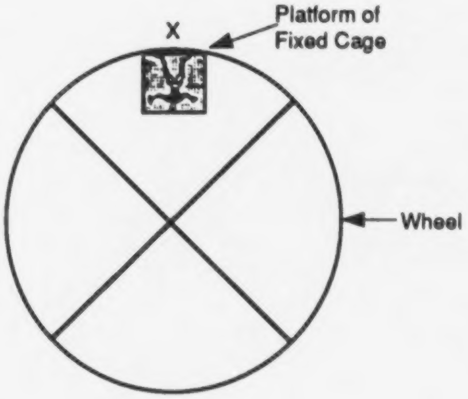
☐ I and III only.

☐ I and IV only.

☐ II, III and IV only.

18. A giant wheel has a diameter of 40 m. The wheel is fitted with a fixed cage and platform on which a man of mass m can stand. The wheel is rotated vertically at such a speed that the force exerted by the man on the platform when the cage and platform are at position X is equal in magnitude to the force of gravity on the man. ($g = 10$ m/s^2)

What is the net force on the man as the platform passes point X?



☐ zero

☐ mg down

☐ mg up

☐ 2 mg down

☐ 2 mg up

19. Which of the following occurs when a new branch is added to a parallel circuit?

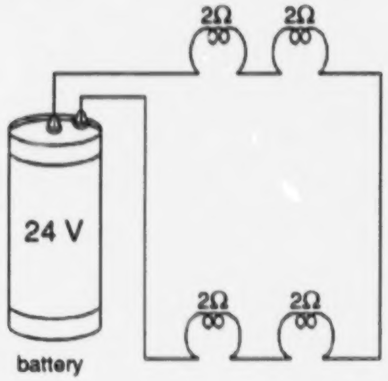
☐ The voltage in the older branches increases.

☐ The total resistance decreases.

☐ The total current decreases.

☐ The voltage in the entire circuit decreases.

20. The current in the wire is



☐ 3 amperes.

☐ 8 amperes.

☐ 24 amperes.

☐ 32 amperes.

21. Alpha particles discharge a charged electroscope by

☐ causing water vapor to form around the electroscope.

☐ making the air around the electroscope radioactive.

☐ adding their negative charge to the electroscope.

☐ ionizing the air around the electroscope.

☐ attracting protons from the electroscope.

22. A student has heated an iron ball, weighing 30 g, to red heat over a Bunsen burner. He wishes to know the temperature of the ball. To find out, he drops the ball into a vacuum flask containing 100 g of water at 10°C. The final temperature of the water and the ball was 50°C. What was the approximate temperature of the red-hot ball? [Hint: The specific heat of iron is 0.10; assume no change in the temperature of the flask; assume any steam condenses within the flask.]

☐ 1233°C

☐ 1333°C

☐ 1283°C

☐ 1383°C

23. Microwaves rather than low frequency radiowaves are used in cooking because they have

☐ shorter wavelength with higher energy.

☐ lower frequency with higher energy.

☐ longer wavelength with lower energy.

☐ higher frequency with lower energy.

24. Newton and other supporters of the PARTICLE theory of light predicted that light traveling from air to glass would

☐ speed up and bend toward the normal.

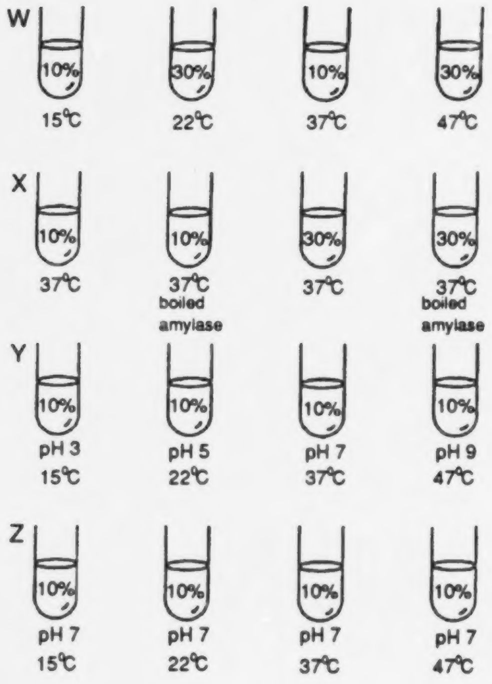
☐ slow down and bend toward the normal.

☐ speed up and bend away from the normal.

☐ slow down and bend away from the normal.

25. Four experiments, labeled W, X, Y, and Z, were designed to test the effect of temperature on the activity of enzyme amylase. The four test tubes in each experiment contained 5 mL of a starch suspension at the concentration indicated as well as 1 mL of amylase suspension at a constant concentration. All test tubes and their contents were incubated at the temperatures indicated for 1 h.

Which experimental design was MOST appropriate for gathering data about the problem under investigation?


W
10%
15°C
30%
22°C
10%
37°C
30%
47°C
X
10%
37°C
10%
37°C
boiled amylase
30%
37°C
30%
37°C
boiled amylase
Y
10%
pH 3
15°C
10%
pH 5
22°C
10%
pH 7
37°C
10%
pH 9
47°C
Z
10%
pH 7
15°C
10%
pH 7
22°C
10%
pH 7
37°C
10%
pH 7
47°C

☐ W

☐ X

☐ Y

☐ Z

26. In the process of fermentation, glucose is broken down into carbon dioxide and alcohol, with the evolution of some energy. With respect to this process, it can also be said that,

☐ entropy is increasing as the reaction takes place.

☐ the free energy of the system is increasing.

☐ entropy is being converted into free energy.

☐ the reaction violates the second law of thermodynamics.

☐ the released energy is eventually used to produce more glucose.

27. When you are exercising vigorously, your muscle cells are unable to obtain oxygen from your blood at a sufficient rate. As a result, the muscle cells

☐ stop functioning, resulting in cramps.

☐ activate anaerobic metabolism, producing lactic acid and releasing energy.

☐ get their energy from oxidative phosphorylation instead.

☐ use the 4-carbon shunt as an alternative source of energy.

☐ use lactic acid to synthesize glycogen for the glycolytic pathway.

28. The table below lists the concentration of substances in blood plasma and urine. From your own knowledge and the table it is possible to conclude all of the following EXCEPT

Substance	Plasma (g/100 ml)	Urine (g/100 ml)
Water	90-93	96
Proteins	7-9	0
Urea	0.03	2
Glucose	0.10	0
Sodium, chloride	0.69	0.95

☐ urea is not reabsorbed from kidney tubules into the capillaries of the nephron.

☐ the proteins are reabsorbed into the capillaries after being filtered at the Bowman's capsule.

☐ in animals adapted to desert conditions, the concentration of water in urine would be less than 96g/100ml.

☐ if there is a lack of salt in the diet the concentration of sodium chloride in the urine could be less than 0.95g/100ml.

29. By using enzymes such as EcoRI, genetic engineers can now

☐ cure all genetic disorders.

☐ determine the sequence of all the bases in human DNA.

☐ fuse together cells from different organisms.

☐ insert DNA from one organism into the DNA of another organism.

☐ repair all abnormal genes in humans.

30. The enzyme catalase, which promotes the decomposition of hydrogen peroxide into water and oxygen, was extracted from fresh liver. The extract was then divided into 5 equal portions which were placed in water baths at a range of temperatures.

Students tested the activity of the enzyme by dropping small filter paper discs, soaked in hydrogen peroxide, into each extract solution. The activity of the catalase caused bubbles of oxygen to form on the discs, causing the discs to float to the surface. The more active the catalase, the faster the discs floated to the surface.

At which temperature would the activity of the enzyme be greatest?

☐ 37° C

☐ 10° C

☐ 25° C

☐ 5° C

☐ 95° C

31. The first cells were probably

☐ autotrophs.

☐ coacervates.

☐ heterotrophs.

☐ microspheres.

32. The following events are thought to occur during the process of evolution.

I. New species appear.

II. Mutations occur.

III. The frequency of the mutant genes in the population increases.

IV. Natural selection favors some variants which thus reproduce more frequently.

According to the theory of evolution, what is the correct sequence of these events?

☐ I, II, III, IV

☐ I, II, IV, III

☐ II, III, IV, I

☐ II, IV, III, I

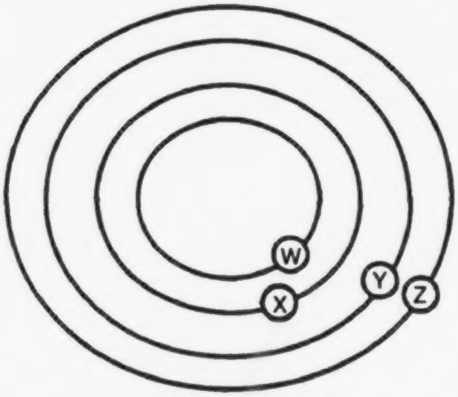
Form 4
Easy

1. The parallax of nearby stars is useful for determining their

☐ distance from Earth.
☐ surface temperature.
☐ diameter.
☐ age.

2. The diagram below represents four planets, W, X, Y, and Z, traveling in elliptical orbits around a star.

Which is the order of the planets from shortest period of revolution to longest?



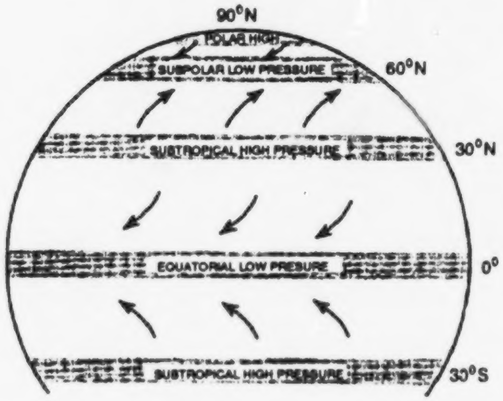
(DRAWN TO SCALE)

☐ X, W, Z, Y
☐ W, X, Y, Z
☐ Y, Z, W, X
☐ Z, Y, X, W

3. The boundary where two air masses meet is called a

☐ center.
☐ high.
☐ low.
☐ front.

4. The diagram below shows a portion of the Earth's prevailing winds and pressure belts. The best inference that can be made from this diagram is that winds blow from regions of


90°N
POLAR HIGH
SUBPOLAR LOW PRESSURE
60°N
SUBTROPICAL HIGH PRESSURE
30°N
EQUATORIAL LOW PRESSURE
0°
SUBTROPICAL HIGH PRESSURE
30°S

☐ high temperature to regions of low temperature.

☐ high latitude to regions of low latitude.

☐ high pressure to regions of low pressure.

☐ high elevation to regions of low elevation.

5. As waves approach shallow water at an angle, one end of the wave hits the shallow water first and

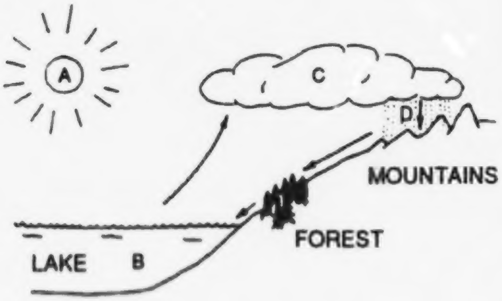
☐ speeds up.

☐ slows down.

☐ stays the same.

☐ stops.

6. The diagram shows the water cycle. The energy source for the water cycle is shown by letter


A
C
D
MOUNTAINS
FOREST
LAKE
B

☐ A

☐ B

☐ C

☐ D

7. Which of the following is a model rather than an observation?

☐ The temperature at the bottom of a very deep well is higher than the temperature at the surface.

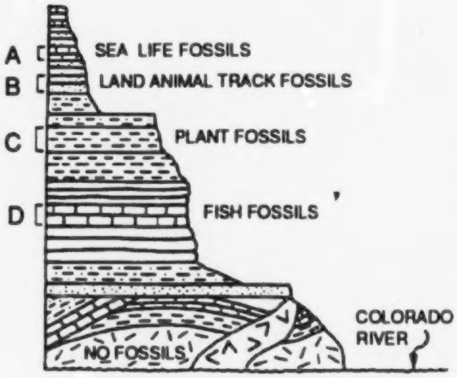
☐ A ship can start from a point, sail around the Earth, and return to the same point.

☐ The center of the Earth is liquid.

☐ The average temperature of the South Pole is lower than the average temperature at the Tropic of Capricorn.

☐ The top of the sail is the last portion of a ship that can be seen from the shore as the ship sails away from the shore.

8. A diagram of the Grand Canyon is shown below. It shows the rock layers and the type of fossils found in each layer. Which rock layer most likely contains the oldest fossils?


A
SEA LIFE FOSSILS
B
LAND ANIMAL TRACK FOSSILS
C
PLANT FOSSILS
D
FISH FOSSILS
NO FOSSILS
COLORADO RIVER

☐ A

☐ B

☐ C

☐ D

9. The best way to tell table salt from sand is to

☐ smell each one.

☐ mix each one with water.

☐ look at the color of each one.

☐ look at the particle size of each one.

10. As the atomic numbers of the elements in a family of the Periodic Table increase, the

☐ atomic radii decrease.

☐ atomic masses decrease.

☐ ionization energies decrease.

☐ metallic characteristics decrease.

11. Where does the energy in the explosion of a firecracker come from?

☐ New energy is created when gun powder explodes.

☐ The chemical energy in the powder is converted into heat, light and sound.

☐ The air around the firecracker provides the sudden energy.

☐ Most of the energy comes from the match that lights the firecracker.

12. Ammonia (NH_3) is produced industrially by reacting nitrogen and hydrogen.

$N_2 + 3H_2 \rightleftharpoons 2NH_3$

The reaction does not go to completion, that is, there is always some nitrogen and hydrogen left at the end of the reaction. The table shows the volume of ammonia (in m^3) produced at various temperatures and pressures when 1 m^3 of nitrogen is reacted with 3 m^3 of hydrogen. From the table below it can be concluded that the amount of ammonia produced increases as

Temperature	Pressure (in atmospheres)				
(°C)	25	50	100	200	400
100	1.91	1.95	1.96	1.98	1.99
200	1.56	1.69	1.80	1.99	1.94
300	0.86	1.13	1.38	1.60	1.77
400	0.32	0.53	0.81	1.12	1.43
500	0.11	0.21	0.38	0.62	0.97

☐ the temperature increases and the pressure decreases.

☐ the temperature increases and the pressure increases.

☐ the temperature decreases and the pressure increases.

☐ the temperature decreases and the pressure decreases.

13. One cubic meter of water is equal in volume to

☐ 10 dm^3 (cubic decimeter).

☐ 100 dm^3 (cubic decimeter).

☐ 1000 dm^3 (cubic decimeter).

☐ 10000 dm^3 (cubic decimeter).

14. When pieces of zinc are added to a strong solution of hydrochloric acid, the zinc dissolves and hydrogen gas is released.

If the reaction stops, two of the following actions would make the reaction start again and produce more gas.

I. If some of the zinc has not dissolved, add more zinc.

II. If some of the zinc has not dissolved, add more acid.

III. If all of the zinc has dissolved, add more acid.

IV. If all if the zinc has dissolved, add more zinc.

Which two actions would make the reaction start again?

☐ I and II

☐ I and III

☐ I and IV

☐ II and III

☐ II and IV

☐ III and IV

15. Volume and mass are properties of

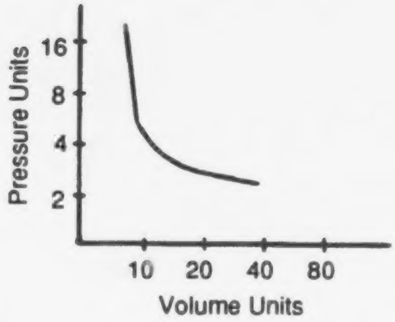
☐ electricity.

☐ heat.

☐ light.

☐ matter.

16. From the graph, predict the pressure of the gas at a volume of 80 units.



☐ 2 units

☐ 4 units

☐ 6.5 units

☐ 10 units

17. A moving object continues to move forward unless acted on by a force. Which device is most directly based on this principle?

☐ telephone

☐ microscope

☐ seatbelt

☐ X-ray machine

18. This question involves two statements:

I. A hockey puck sliding on ice eventually comes to rest.

II. There is a force of friction between the ice and a sliding hockey puck.

Which of the following responses correctly describes the two statements?

☐ Both statements are true and one statement can be used to explain the other.

☐ Both statements are true, but neither statement can be used to explain the other.

☐ Statement I is true. Statement II is false.

☐ Statement I is false. Statement II is true.

☐ Statement I is false. Statement II is false.

19. An electric current flowing through a metallic wire consists of a flow of

☐ charged atoms.

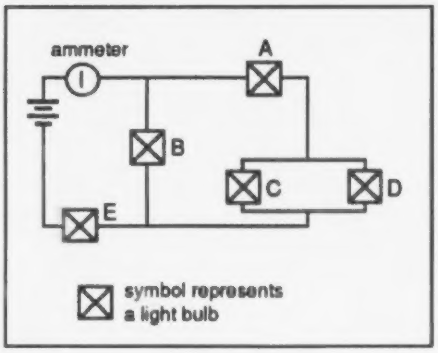
☐ negative electrons.

☐ negative ions.

☐ positive ions.

☐ positive protons.

20. In the circuit shown below, which single light bulb of the five shown in the circuit should be removed from its socket so that the ammeter will read zero?


ammeter
I
A
B
C
D
E
symbol represents a light bulb

☐ A

☐ B

☐ C

☐ D

☐ E

21. The temperature at which a substance changes from a solid to a liquid is called its

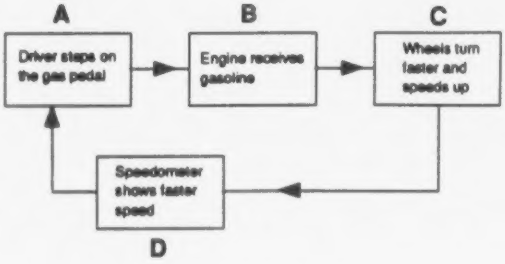
☐ melting point.

☐ saturation point.

☐ solubility point.

☐ boiling point.

22. The diagram below shows steps involved when a driver changes a cars speed from 40 to 50 miles per hour. Which step represents feedback in this system?


A
Driver steps on the gas pedal
B
Engine receives gasoline
C
Wheels turn faster and speeds up
Speedometer shows faster speed
D

☐ A

☐ B

☐ C

☐ D

23. The intensity of sound is measured in units of

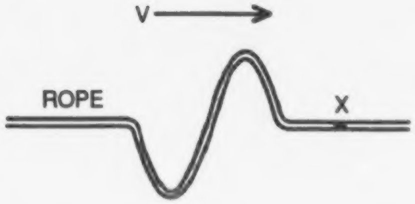
☐ hertz.

☐ decibels.

☐ watts.

☐ tones.

24. As shown in the diagram below, a transverse wave is moving along a rope. In which direction will segment X move as the wave passes through it?



☐ down, only

☐ up, only

☐ up, then down

☐ down, then up

25. If the magnifying power of the eyepiece lens is × 10, and that of the objective lens is × 10, what is the total magnification of the microscope?

☐ × 10

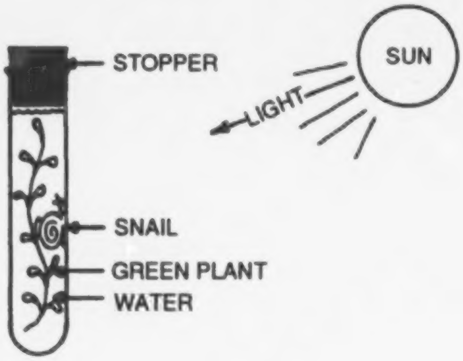
☐ × 20

☐ × 30

☐ × 100

☐ × 1000

26. In the test tube shown below, what is produced by the snail and used by the green plant?



☐ carbon dioxide

☐ egg cells

☐ food

☐ oxygen

27. Blood picks up fresh supplies of oxygen in the

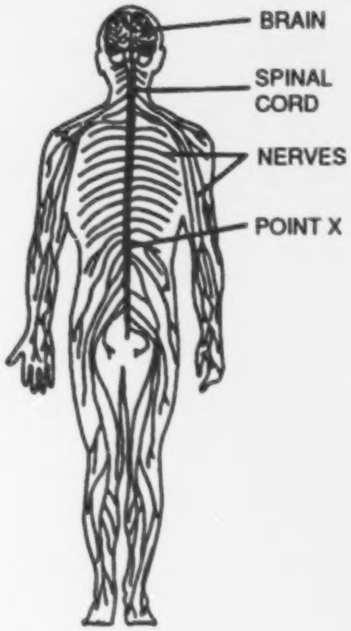
☐ arteries.

☐ trachea.

☐ lungs.

☐ heart.

28. The diagram below shows the human nervous system. If a person's spinal cord is accidentally cut at point X, which activity would not be possible for this person?



☐ talking
☐ walking
☐ throwing a ball
☐ feeling pain in the shoulders

29. Cancer is best described as

☐ a disease of the aged.
☐ an inherited disease.
☐ a consequence of infection.
☐ uncontrolled cell division.
☐ a disease of the blood which then spreads to other parts of the body.

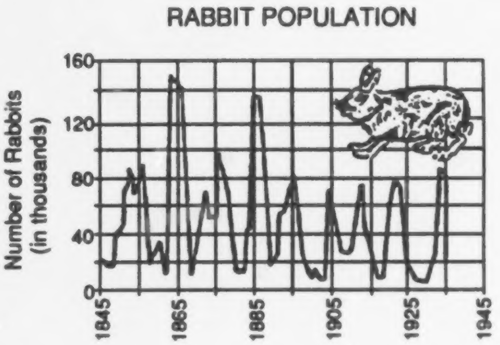
30. The reason there are so many more varieties of domestic dogs than of wild dogs is:

☐ Mutation
☐ Natural
☐ Artificial selection
☐ Convergent evolution
☐ Divergent evolution

31. If we assume that species do not change, we would expect to find

☐ the simplest fossils in the oldest rocks.
☐ the simplest fossils in the newest rocks.
☐ the same kind of fossils in old and new rocks.
☐ no fossils in any rocks.

32. According to the graph below, which of the following would most likely have been true in 1865?



☐ There was plenty of grass and few foxes.
☐ There was little grass and few foxes.
☐ There was plenty of grass and many foxes.
☐ There was little grass and many foxes.
☐ One cannot tell from the information given.

Form 4
Intermediate

1. The parallax of nearby stars is useful for determining their

☐ distance from Earth.

☐ surface temperature.

☐ diameter.

☐ age.

2. What is the most important reason why Mars has less energy available on its surface than Earth has?

☐ Its atmosphere has a larger percent of of carbon dioxide.

☐ Its diameter is smaller.

☐ Its supply of radioactive minerals is much smaller.

☐ It's farther from the Sun.

3. The boundary where two air masses meet is called a

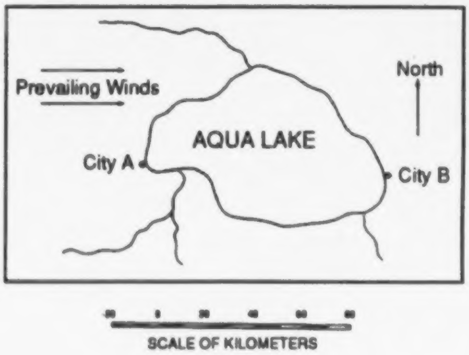
☐ center.

☐ high.

☐ low.

☐ front.

4. The map below shows two cities, A and B, situated at the same latitude on a lake that does not freeze. The prevailing winds are from the west. During a winter day



☐ City A would likely have the same temperature as City B.

☐ City A would likely be cooler than City B.

☐ City A would likely be warmer than City B.

5. Why do particles, carried by a river, settle to the bottom as the river enters the ocean?

☐ The density of the ocean water is greater than the density of the river water.

☐ The kinetic energy of the particles increases as the particles enter the ocean.

☐ The velocity of the river water decreases as it enters the ocean.

☐ The large particles have a greater surface area than the small particles.

6. When the amounts of water entering and leaving a lake are balanced, the volume of the lake remains the same. This balance is called

☐ saturation.

☐ transpiration.

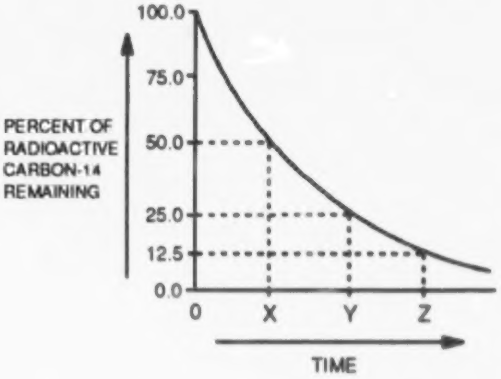
☐ equilibrium.

☐ permeability.

7. The geological dating method which is believed to be most accurate is

- ☐ rate of erosion.
- ☐ rate of deposition of sediments.
- ☐ amount of salt in the area.
- ☐ radioactivity.

8. The graph below shows the percent remaining (not decayed) of the original amount of carbon-14 at different times (X, Y, and Z) during radioactive decay. How many half-lives of time are represented by point Y along the time axis?



- ☐ 1 half-life
- ☐ 2 half-lives
- ☐ 3 half-lives
- ☐ 4 half-lives

9. The electronegativity value of an element is a measure of the atom's

- ☐ ability to attract protons.
- ☐ ability to attract electrons.
- ☐ degree of conductivity.
- ☐ degree of stability.

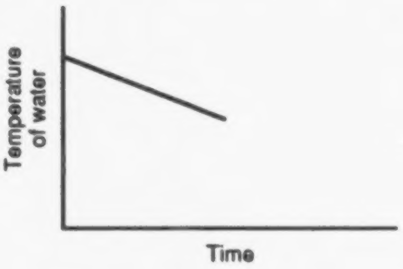
10. As the atomic numbers of the elements in a family of the Periodic Table increase, the

- ☐ atomic radii decrease.
- ☐ atomic masses decrease.
- ☐ ionization energies decrease.
- ☐ metallic characteristics decrease.

11. A correct interpretation about an exothermic reaction is that, during the reaction, the

- ☐ reactants gain energy to form products.
- ☐ surroundings lose energy.
- ☐ surroundings gain energy.
- ☐ enthalpy of the products is greater than the enthalpy of the reactants.

12. A student performs an experiment using a calorimeter that contains water. The graph below is produced from the data. The best interpretation from the data is that the reaction is



- ☐ endothermic and that the kinetic energy of the water is decreasing.
- ☐ endothermic and that the kinetic energy of the water is increasing.
- ☐ exothermic and that the kinetic energy of the water is decreasing.
- ☐ exothermic and that the kinetic energy of the water is increasing.

13. The universally accepted standard for atomic and molecular masses is

☐ 1/12 of the mass of the most common isotope of carbon.

☐ 1/16 of the mass of the most common isotope of oxygen.

☐ the mass of the most common isotope of hydrogen.

☐ the mass of a standard at the National Bureau of Standards.

14. Which is the expression for the free energy change of a chemical reaction?

☐ $\Delta H = \Delta G - T\Delta S$

☐ $\Delta G = \Delta S - T\Delta H$

☐ $\Delta G = \Delta H - T\Delta S$

☐ $\Delta S = \Delta G - T\Delta H$

15. Aqueous hydrogen ion, in solution, may be detected by

☐ a bitter taste.

☐ litmus paper turning blue.

☐ a soapy texture.

☐ reaction with magnesium ribbon.

16. The pH of a basic solution that has an $[OH^-(aq)]$ of 6.4×10^{-3} mol/L is

☐ 1.00

☐ 2.19

☐ 11.81

☐ −11.81

17. Consider the four units given below.

I. $kg\text{-}m/s^2$

II. J

III. N-m

IV. kW-h

Which of the above are units of energy?

☐ I and II only.

☐ II and III only.

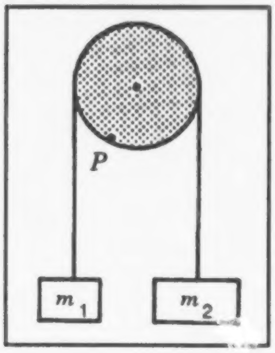
☐ II and IV only.

☐ II, III and IV only.

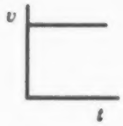
☐ All are units of energy.

18. Two masses m_1 and m_2 are attached to opposite ends of a cord placed around a pulley as shown in the diagram below. There is no friction between the pulley and its axle, but there is friction between the string and the pulley. m_2 has a greater mass than m_1. Both masses are held stationary at the same horizontal level as shown and then released.

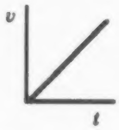
Which of the graphs below best describes the speed v of the fixed point P on the pulley as a function of time t?



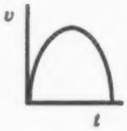
1



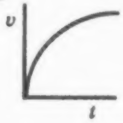
2



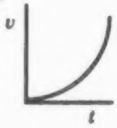
3



4



5



☐ 1

☐ 2

☐ 3

☐ 4

☐ 5

19. Solid materials which are good conductors of electricity have many loosely bound

☐ neutrons.

☐ electrons.

☐ protons.

☐ nuclei.

20. Figures I, II and III show three ways four batteries and two lights could be wired. In I, the batteries and the bulbs are wired in series. In II, the batteries are wired in series, the bulbs in parallel. In III, the batteries are wired in parallel, the bulbs in series. Which wiring gives the brightest and dimmest light from the bulbs?

Figure I

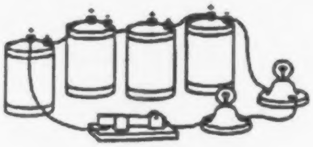


Figure II

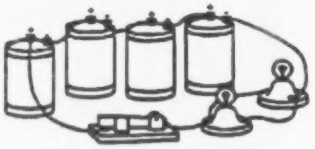
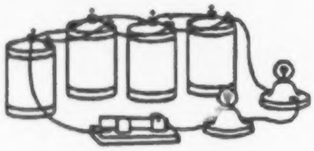


Figure III



☐ I is brightest; II is dimmest.

☐ I is brightest; III is dimmest.

☐ II is brightest; III is dimmest.

☐ III is brightest; I is dimmest.

☐ II is brightest; I is dimmest.

21. Materials that are very poor conductors of heat are called

☐ thermostats.

☐ thermocouples.

☐ insulators.

☐ radiators.

22. If the same amount of heat energy is supplied without loss to two different substances of equal mass, their final temperatures may be different because they have different

☐ abilities to conduct heat.

☐ coefficients of expansion.

☐ densities.

☐ volumes.

☐ specific heat capacities.

23. The light emitted by a gas discharge tube is caused by

☐ return of excited electrons to lower energy states.

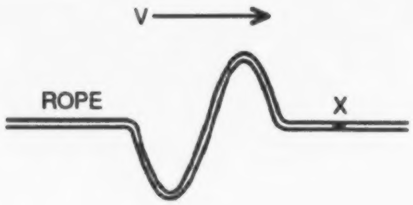
☐ escape of free electrons from the cathode.

☐ friction between electrons in the tube.

☐ radioactive emanations from the gas in the tube.

☐ radioactive emanations from the glass envelope.

24. As shown in the diagram below, a transverse wave is moving along a rope. In which direction will segment X move as the wave passes through it?



☐ down, only

☐ up, only

☐ up, then down

☐ down, then up

25. Which is the correct sequence of historical developments leading to our present knowledge of cells?

☐ electron microscope → cell theory → compound light microscope

☐ compound light microscope → cell theory → electron microscope

☐ cell theory → electron microscope → compound light microscope

☐ electron microscope → compound light microscope → cell theory

26. An hypothesis can be a statement in the form "if something is true, then something else should happen". The part of the statement after the "then" is usually a prediction that can be experimentally tested. Choose the most appropriate ending to complete the following hypothesis.

If increasing the concentration of carbon dioxide increases the rate of photosynthesis, then

☐ increasing the temperature should increase the rate of oxygen production.

☐ increasing the duration of light should increase the rate of photosynthesis.

☐ increasing the concentration of carbon dioxide should increase the rate of glucose production.

☐ increasing the concentration of carbon dioxide should decrease the rate of glucose consumption.

☐ changing the quality of light should change the rate of glucose production.

27. Inhalation is MOST directly a response to

☐ low O_2 concentration.

☐ high CO_2 concentration.

☐ an action of the cerebellum.

☐ a lack of nerve impulses to the diaphragm and muscles of the rib cage.

28. Use the information in the table below to answer this question. The conclusion that nephrons selectively filter molecules from the plasma in the production of glomerular filtrate is supported by the results shown for

Glomerular Filtrate Compared to Plasma and Urine

Main Components	Fluid (g/100 mL)		
	Plasma	Glomerular Filtrate	Urine
Urea	0.030	0.030	2.000
Uric acid	0.004	0.004	0.050
Glucose	0.100	0.100	Trace
Amino acids	0.050	0.050	Trace
Total inorganic salts	0.720	0.720	1.500
Proteins and other macromolecules	8.000	0.000	0.000

☐ proteins and other macromolecules.

☐ glucose.

☐ total inorganic salts.

☐ urea.

29. Cancer is best described as

☐ a disease of the aged.

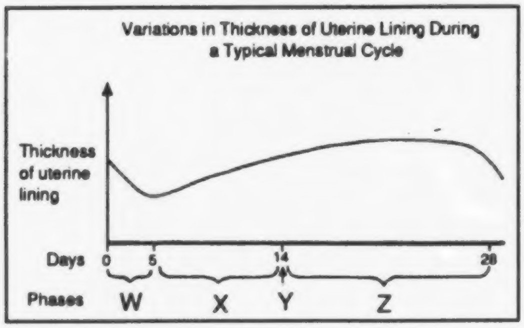
☐ an inherited disease.

☐ a consequence of infection.

☐ uncontrolled cell division.

☐ a disease of the blood which then spreads to other parts of the body.

30. During which of the phases in the diagram below does menstruation occur?



☐ W

☐ X

☐ Y

☐ Z

31. Examination of which of the following could not be used to distinguish between monocotyledons and dicotyledons?

☐ Cotyledons

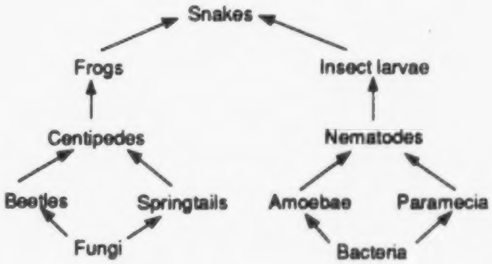
☐ Roots

☐ Petals

☐ Leaf shape

☐ Leaf venation

32. The diagram below illustrates a food web. If all the snakes are removed, which one of the following changes would probably occur in the next two years?


Snakes
Frogs
Insect larvae
Centipedes
Nematodes
Beetles
Springtails
Amoebae
Paramecia
Fungi
Bacteria

☐ The number of nematodes would increase.

☐ The number of frogs would decrease.

☐ The number of insect larvae would decrease.

☐ The number of centipedes would decrease.

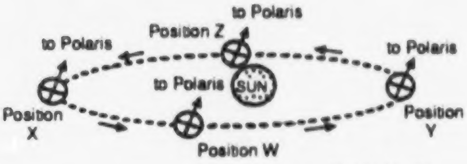
☐ There would be no changes.

Form 4
Difficult

1. Spacecraft transmit or send back pictures of planets and moons by

☐ radio signals.
☐ television signals.
☐ microwave transmission.
☐ LANDSAT satellite systems.

2. For an observer at 40° north latitude, which event will occur when the Earth is at position Y on the diagram below?



Not to Scale

☐ The Sun will be higher in the sky than on any other day.
☐ The length of the daylight period will be shortest.
☐ The Sun will appear to have its smallest diameter.
☐ The Sun will set exactly in the west.

3. The original characteristics of an air mass are largely determined by the

☐ characteristics of the surface over which the air mass formed.
☐ velocity of Earth's rotation at latitude of air mass formation.
☐ amount of solar energy the air mass receives.
☐ type of fronts that surround the air mass.

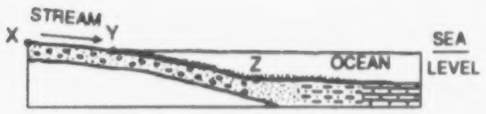
4. If Earth's mass remained the same but its diameter were reduced to half its present size, what would be the effect on Earth's atmosphere?

☐ It would expand and escape into space.
☐ It would contain more oxygen and less nitrogen.
☐ It would increase in density and decrease in volume.
☐ It would decrease in density and in water vapor content.

5. What changes occur as waves move from deep water to shallow water?

☐ speed increases, wavelength increases, waves bend towards shore
☐ speed increases, wavelength decreases, waves bend away from shore
☐ speed decreases, wavelength decreases, waves bend away from shore
☐ speed decreases, wavelength decreases, waves bend towards shore

6. The diagram below shows the pattern of deposition of stream-carried sediments on the ocean floor. If the stream's erosional rate is equal to its depositional rate between points X and Y, the stream is said to be in



☐ a state of uplift.

☐ a state of subsidence.

☐ environmental imbalance.

☐ dynamic equilibrium.

7. A seismic station records an earthquake tremor. The secondary or S-wave arrives 5 minutes after the primary, or P-wave. What can be determined about the earthquake from this one seismic station?

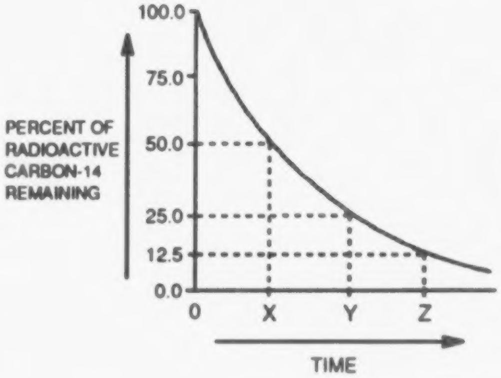
☐ the distance from the seismic station to the epicenter

☐ the distance to the focus from the Earth's surface

☐ the location of the epicenter

☐ amount of damage caused by the earthquake

8. The graph below shows the percent remaining (not decayed) of the original amount of carbon-14 at different times (X, Y, and Z) during radioactive decay. How many half-lives of time are represented by point Y along the time axis?



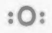
☐ 1 half-life

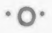
☐ 2 half-lives

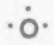
☐ 3 half-lives

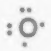
☐ 4 half-lives

9. The Lewis dot diagram for oxygen with the electron configuration $1s^2\ 2s^2\ 2p^4$ is

W 

X 

Y 

Z 

☐ W

☐ X

☐ Y

☐ Z

10. The halogens have similar chemical properties because they all

☐ are colored gases.

☐ have the same number of protons.

☐ have the same atomic mass.

☐ have the same number of valence electrons.

11. Which four of the following factors affect the rates of homogeneous chemical reactions?

I. catalyst
II. entropy
III. free energy
IV. temperature
V. concentration of reactants
VI. enthalpy
VII. physical nature of reactants
VIII. equilibrium constant

☐ I, IV, V, VII

☐ II, IV, VI, VIII

☐ I, IV, VI, VII

☐ III, V, VII, VIII

12. $KClO_3$ (potassium chlorate) decomposes according to the equation:

$2KClO_3 \rightarrow 2KCl + 3O_2$

If 12.25 g of $KClO_3$ is totally decomposed, what mass of O_2 is produced? (Atomic masses: Cl = 17, K = 19, and O = 8.)

☐ 1.6 g

☐ 3.2 g

☐ 4.8 g

☐ 9.6 g

13. The universally accepted standard for atomic and molecular masses is

☐ 1/12 of the mass of the most common isotope of carbon.

☐ 1/16 of the mass of the most common isotope of oxygen.

☐ the mass of the most common isotope of hydrogen.

☐ the mass of a standard at the National Bureau of Standards.

14. Consider the equation:

$CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$

"20 mL of carbon monoxide, CO, and 10 mL of oxygen, O_2, react forming 20 mL of carbon dioxide, CO_2." This statement illustrates all of the following EXCEPT

I. Avogadro's Principle

II. Law of Multiple Proportions

III. Boyle's Law

IV. Gay-Lussac's Law of Combining Gas Volumes

☐ I

☐ II

☐ III

☐ IV

15. A solution that turns blue when potassium ferricyanide ($K_3Fe(CN)_6$) is added must contain

☐ $Fe^{2+}(aq)$

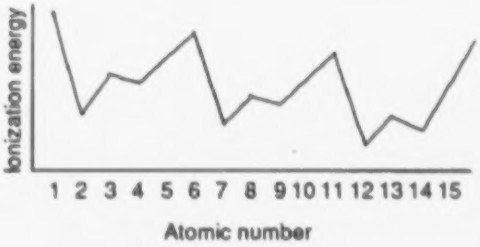
☐ $Fe^{3+}(aq)$

☐ $NO_3^-(aq)$

☐ $Ag^+(aq)$

16. Listed below are fifteen fictitious elements and an experimentally produced graph of their first ionization energies. From this information determine which type of compound will most likely be formed between geranium and jothrium.

Atomic Number	Symbol	Name of Element
1	A	aquarius
2	B	butyrium
3	C	clutter
4	D	doople
5	E	effressium
6	F	floogium
7	G	geranium
8	H	hoople
9	I	inklium
10	J	jothrium
11	K	kringlium
12	L	lucium
13	M	mentium
14	N	noxium
15	O	oogle



☐ network solid

☐ ionic solid

☐ covalent molecule

☐ diatomic gas

17. Consider the four units given below.

I. kg-m/s^2

II. J

III. N-m

IV. kW-h

Which of the above are units of energy?

☐ I and II only.

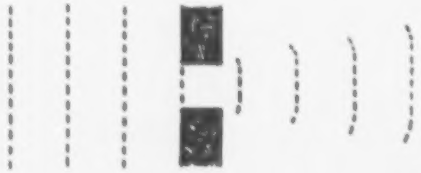
☐ II and III only.

☐ II and IV only.

☐ II, III and IV only.

☐ All are units of energy.

18. The diagram shows the phenomena of dispersion when periodic waves of frequency f pass through a narrow opening. This phenomena can be made more pronounced by



☐ making the opening wider.

☐ making the frequency higher.

☐ making the opening wider OR making the frequency higher.

☐ neither by making the opening wider NOR making the frequency higher.

19. Whenever a net charge is placed on an object by induction, the kind of charge on the object

- ☐ is the same as the charge on the charging agent.
- ☐ is opposite to the charge on the charging agent.
- ☐ depends on whether separation or grounding is used.
- ☐ depends on the kind of material making up the object.
- ☐ returns to neutral once the charging agent is removed.

20. At a distance of 2.0 m from a $+8.0 \times 10^{-6}$ C charge, the magnitude and direction of the electric field will be

- ☐ 3.6×10^4 N/C, towards the charge.
- ☐ 3.6×10^4 N/C, away from the charge.
- ☐ 1.8×10^4 N/C, towards the charge.
- ☐ 1.8×10^4 N/C, away from the charge.

21. One reason why so much energy is released when an atomic nucleus splits is that

- ☐ some of the mass of the nucleus is converted to energy.
- ☐ a violent chemical reaction is the main event in nuclear fission.
- ☐ a chain reaction is inevitable.
- ☐ it takes a tremendous amount of energy to break a nucleus apart.
- ☐ all of the mass of the nucleus is converted to energy.

22. For object X to have a higher absolute temperature than object Y, object X must have a

- ☐ higher average internal potential energy.
- ☐ higher average internal kinetic energy.
- ☐ greater mass.
- ☐ greater specific heat.

23. In the spectrum of the sun a continuous spectrum is crossed by many black lines (Fraunhofer lines). Which of the following statements is correct?

- ☐ The black lines are caused by Fraunhofer diffraction at the telescope.
- ☐ The black lines are caused by the absorption of light by the gases of the Sun's atmosphere.
- ☐ The spectrum of the Sun lacks the spectral lines of all the elements present in the Sun.
- ☐ The black lines come from the combustion of elements at the Sun.
- ☐ The spectrum of the Sun is changed in the space between Sun and Earth by cosmic radiation.

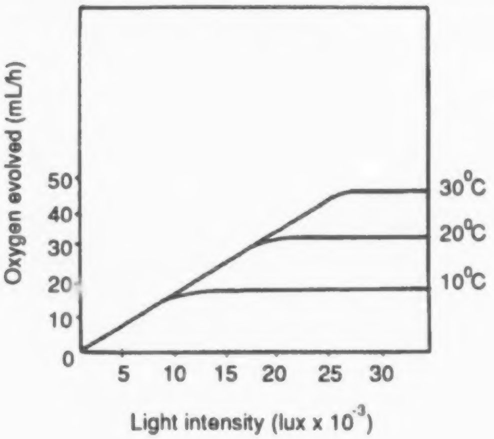
24. A radio signal is sent from city X to city Y by reflection from the ionosphere, which is 1.73×10^5 m above the Earth's surface. The signal is beamed from X and makes an angle of 60.0° with the ground. The distance from city X to city Y is 2.00×10^5 m. If the effects of the curvature of the earth are neglected, the time it takes for the radio signal to reach city Y is

- ☐ 5.57×10^{-4} s
- ☐ 6.65×10^{-4} s
- ☐ 1.33×10^{-3} s
- ☐ 1.15×10^{-3} s

25. With the aid of the graph, evaluate the following statement:

"High temperatures only affect the rate of photosynthesis at high light intensities."

RATE OF PHOTOSYNTHESIS IN CORN (ZEA MAYS)



☐ The statement is incorrect and can be determined from the data.

☐ The statement is correct but can NOT be determined from the data.

☐ The statement is correct and can be determined from the data.

☐ The statement is incorrect but can NOT be determined from the data.

26. An hypothesis can be a statement in the form "if something is true, then something else should happen". The part of the statement after the "then" is usually a prediction that can be experimentally tested. Choose the most appropriate ending to complete the following hypothesis.

If increasing the concentration of carbon dioxide increases the rate of photosynthesis, then

☐ increasing the temperature should increase the rate of oxygen production.

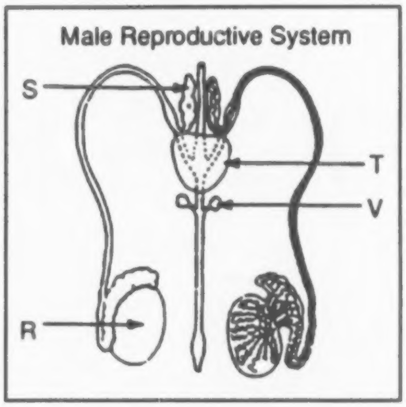
☐ increasing the duration of light should increase the rate of photosynthesis.

☐ increasing the concentration of carbon dioxide should increase the rate of glucose production.

☐ increasing the concentration of carbon dioxide should decrease the rate of glucose consumption.

☐ changing the quality of light should change the rate of glucose production.

27. Growth of muscle tissue is promoted by secretions from the structure labeled



☐ R
☐ S
☐ T
☐ V

28. Use the information in the table below to answer this question. The conclusion that nephrons selectively filter molecules from the plasma in the production of glomerular filtrate is supported by the results shown for

Glomerular Filtrate Compared to Plasma and Urine

Main Components	Fluid (g/100 mL)		
	Plasma	Glomerular Filtrate	Urine
Urea	0.030	0.030	2.000
Uric acid	0.004	0.004	0.050
Glucose	0.100	0.100	Trace
Amino acids	0.050	0.050	Trace
Total inorganic salts	0.720	0.720	1.500
Proteins and other macromolecules	8.000	0.000	0.000

☐ proteins and other macromolecules.

☐ glucose.

☐ total inorganic salts.

☐ urea.

29. The four chemical elements that make up all amino acid molecules are: carbon, hydrogen,

☐ oxygen and phosphorus.

☐ oxygen and nitrogen.

☐ oxygen and sulfur.

☐ nitrogen and phosphorus.

☐ nitrogen and sulfur.

30. The great diversity of structure in proteins is mainly due to

☐ different kinds of bonds between successive amino acids.

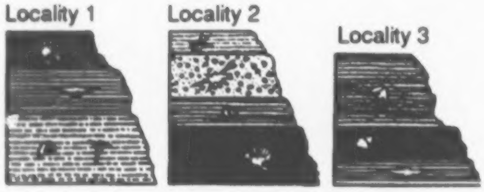
☐ different numbers, kinds, and sequences of amino acids.

☐ the precise location of specific amino acids, common to all proteins.

☐ the action of the ribosomes.

☐ the disulfide and hydrogen bonds which determine molecular shape.

31. Consider the diagrams below. It is reasonable to conclude all the following EXCEPT



☐ the fossils are most likely to be from marine deposits.

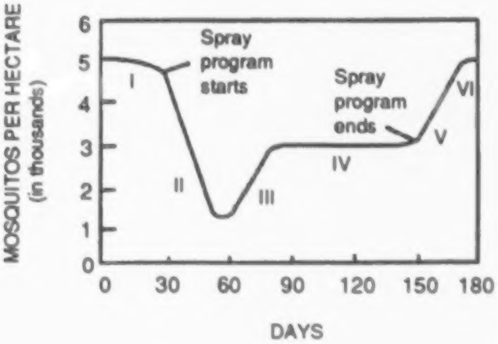
☐ the fossilization process has most likely involved rapid sedimentation.

☐ the most probable reason for the absence of certain fossils in locality 3 is erosion of the top layers.

☐ the absolute age of the fossils can be determined from the position of the strata in which they are located.

32. One summer, a swamp was sprayed with an insecticide at weekly intervals in an attempt to eliminate mosquitoes.

Which process is occurring in section II of the curve below?



☐ repopulation

☐ overpopulation

☐ variation

☐ selection

Form 4
More Difficult

1. Which situation best supports the conclusion that the Sun does not revolve around the Earth?

☐ The Sun appears to rise in the East and set in the West.

☐ The inscribed plane created by a pendulum dangling from a free, motionless swivel appears to rotate.

☐ The star constellations in the winter sky are different from those in the summer sky.

☐ The color of a star appears to change on a six month cycle.

2. The fact that light from distant stars shows a Doppler shift of spectral lines towards the red end of the spectrum, provides most support for which of the following?

☐ the expansion of the universe

☐ the existence of black holes

☐ the evolutionary development of stars

☐ the formation of supernova

3. Atmospheric pressure at sea level is approximately equal to

☐ 1 Pa

☐ 1 kPa

☐ 10 kPa

☐ 100 Pa

☐ 100 kPa

4. The temperature of a rising air parcel decreases 10°C for each km the parcel rises. The dew-point temperature of a rising air parcel decreases 1.7°C for each km the parcel rises. If the sea-level air temperature is 36°C, and the sea-level dew point is 11.1°C, at what altitude will clouds begin to form as the air parcel rises?

☐ 1km

☐ 2km

☐ 3km

☐ 4km

5. The transport and deposition of sediments along a coastline can be interrupted by

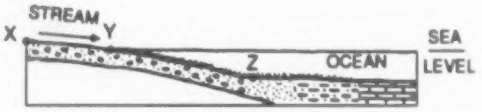
☐ rainfall.

☐ longshore currents.

☐ prevailing wind patterns.

☐ submarine canyons.

6. The diagram below shows the pattern of deposition of stream-carried sediments on the ocean floor. If the stream's erosional rate is equal to its depositional rate between points X and Y, the stream is said to be in



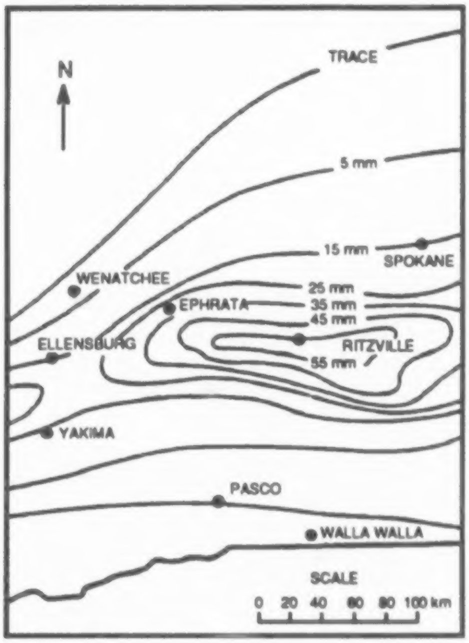
☐ a state of uplift.

☐ a state of subsidence.

☐ environmental imbalance.

☐ dynamic equilibrium.

7. The map below shows isolines of ashfall depths covering a portion of the State of Washington. The ashfall resulted from a volcanic eruption of Mount St. Helens. Which equation should be used to determine the ashfall gradient in millimeters per kilometer between Spokane and Ritzville?


N
TRACE
5 mm
15 mm
SPOKANE
WENATCHEE
EPHRATA
25 mm
35 mm
45 mm
ELLENSBURG
RITZVILLE
55 mm
YAKIMA
PASCO
WALLA WALLA
SCALE
0 20 40 60 80 100 km

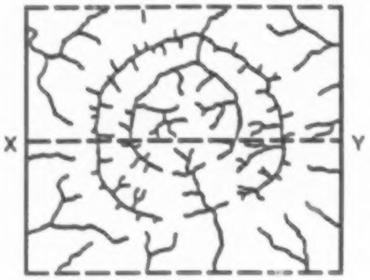
☐ Gradient = (55mm – 15 mm) / 75 km

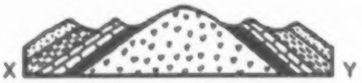
☐ Gradient = 75 km / (55 mm – 15 mm)

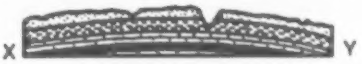
☐ Gradient = (55 mm – 15 mm) / 100 km

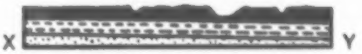
☐ Gradient = 100 km / (55 mm – 15 mm)

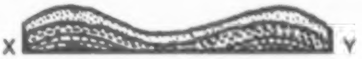
8. The diagram below is a map showing the stream drainage pattern for an area of the Earth's crust. Which geologic cross-section (A, B, C, D, or E) shows the most probable underlying rock structure and surface for this area along line X–Y?

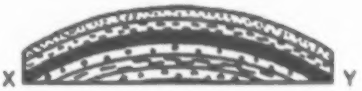


A


B


C


D


E


☐ A

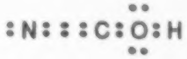
☐ B

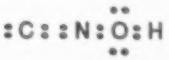
☐ C

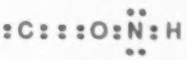
☐ D

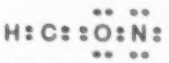
☐ E

9. The formula of cyanic acid is HOCN. The Lewis (electron dot) representation for cyanic acid is

A 
$:N:::C:\overset{..}{\underset{..}{O}}:H$

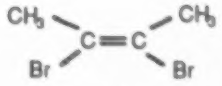
B 
$:C::N:\overset{..}{\underset{..}{O}}:H$

C 
$:C:::O:\overset{..}{\underset{..}{N}}:H$

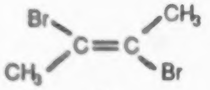
D 
$H:C::\overset{..}{\underset{..}{O}}:\overset{..}{\underset{..}{N}}:$

☐ A
☐ B
☐ C
☐ D

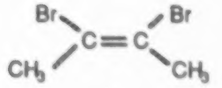
10. Which pair are *cis-trans* isomers?



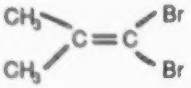
I



II



III



IV

☐ I and III
☐ II and III
☐ III and IV
☐ I and IV

11. Which substance is a conductor of electricity in the liquid phase but not in the solid phase?

☐ Br_2
☐ HBr
☐ Na
☐ NaCl

12. $KClO_3$ (potassium chlorate) decomposes according to the equation:

$2KClO_3 \rightarrow 2KCl + 3O_2$

If 12.25 g of $KClO_3$ is totally decomposed, what mass of O_2 is produced? (Atomic masses: Cl = 17, K = 19, and O = 8.)

☐ 1.6 g
☐ 3.2 g
☐ 4.8 g
☐ 9.6 g

13. Water solutions of which of the following pairs of compounds would NOT be useful as buffers to maintain constant pH?

☐ NH_4OH and NH_4Cl
☐ $HClO_4$ and $KClO_4$
☐ CH_3COOH and CH_3COONa
☐ H_3PO_4 and Na_3PO_4

14. Which expression correctly represents the solubility product constant (K_{sp}) for the following reaction?

$AgI(s) \rightleftharpoons Ag^+(aq) + I^-(aq)$

☐ $K_{sp} = \frac{[Ag^+][I^-]}{[AgI]}$
☐ $K_{sp} = \frac{[AgI]}{[Ag^+][I^-]}$
☐ $K_{sp} = [Ag^+][I^-]$
☐ $K_{sp} = \frac{1}{[Ag^+][I^-]}$

15. A solution that turns blue when potassium ferricyanide ($K_3Fe(CN)_6$) is added must contain

☐ $Fe^{2+}(aq)$

☐ $Fe^{3+}(aq)$

☐ $NO_3^-(aq)$

☐ $Ag^+(aq)$

16. During an experiment to determine the relative strengths of acids, 8.0 g HF dissolved in 2.0 L of water, yielding a pH of 2.08. Using these data, the per cent ionization of this acid is

☐ 20%

☐ 9.0%

☐ 5.9%

☐ 4.2%

17. The figure below represents a multiple-flash photograph taken by an experimenter while studying the motion of a steel ball projected into the air. The ball was photographed through a narrow slit near the edge of a disc spinning at constant speed. The black streaks indicate the path of the ball during the intervals when the slit is in front of the open camera shutter. Sets of measurements which can be made on such a photo include:

the length of each streak, such as KL

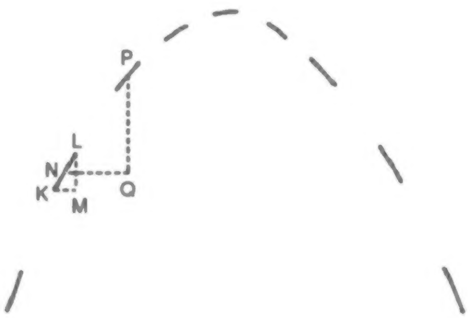
the horizontal extent of each streak, such as KM

the vertical extent of each streak, such as LM

the horizontal distance between the centers of successive streaks, such as NQ

the vertical distance between the centers of successive streaks, such as QP

Which set of measurements will give the most direct indication of the magnitude of the ball's speed at various times?



☐ the length of each streak

☐ the horizontal extent of each streak

☐ the vertical extent of each streak

☐ the horizontal distance between the centers of successive streaks

☐ the vertical distance between the centers of successive streaks

18. The engine of a rocket exerts a constant force of F newtons upward on a rocket of mass m kilograms for a vertical distance of d meters, giving the rocket a velocity of v meters per second upward.

Which of the following expressions summarizes the total work done on the rocket? (Assume that g is constant.)

☐ $Fd = md$

☐ $Fd = mgd$

☐ $Fd = \frac{1}{2}mv^2$

☐ $Fd = \frac{1}{2}mv^2 + mgd$

☐ $Fd = \frac{1}{2}mv^2 - mgd$

19. Whenever a net charge is placed on an object by induction, the kind of charge on the object

☐ is the same as the charge on the charging agent.

☐ is opposite to the charge on the charging agent.

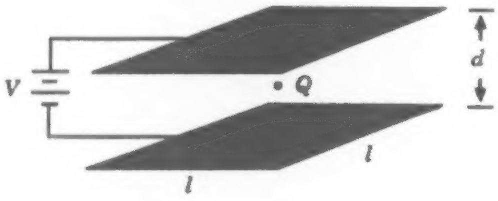
☐ depends on whether separation or grounding is used.

☐ depends on the kind of material making up the object.

☐ returns to neutral once the charging agent is removed.

20. A small sphere carries a charge Q. The sphere is placed between two square metal plates having linear dimensions of l. The plates are separated by a distance d and attached to a battery with an electric potential V. When the battery is disconnected and there is no charge on the plates, the sphere falls with a speed v. When the battery is connected as shown, the sphere rises with a speed $\frac{1}{2}v$.

If the charge is tripled, the separation between the plates is doubled, and the plates are connected to the battery, the sphere will



☐ move downward.

☐ stand still.

☐ move upward at $3v$.

☐ move upward at $\frac{5}{4}v$.

☐ move upward at $2v$.

21. Which of the following has the most penetrating power?

☐ gamma rays

☐ beta particles

☐ cathode rays

☐ alpha particles

☐ X rays

22. For object X to have a higher absolute temperature than object Y, object X must have a

☐ higher average internal potential energy.

☐ higher average internal kinetic energy.

☐ greater mass.

☐ greater specific heat.

23. Suppose that f_o is the focal length of the objective lens of a compound microscope, and f_e is the focal length of the eyepiece. When the microscope is properly focused, the object on the microscope slide

☐ is less than f_o away from the objective lens.

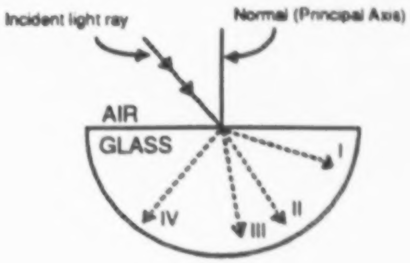
☐ is more than f_o away from the objective lens.

☐ produces an intermediate image which is more than f_e away from the eyepiece.

☐ produces an intermediate image which is more than $2f_e$ away from the eyepiece.

☐ produces an intermediate image which is less than f_e away from the eyepiece.

24. Which numeral in the illustration below indicates where the refracted ray will travel?



☐ I
☐ II
☐ III
☐ IV

25. The loss of water from a plant cell, causing the cytoplasm to shrink away from the cell wall, can be brought about by placing the cell in

☐ distilled water.
☐ water close to the boiling point.
☐ an isotonic solution several degrees above normal temperature.
☐ a 10% solution of calcium chloride.
☐ a 0.5% suspension of starch.

26. Proteins are to ribosomes as ATP is to the

☐ nucleus.
☐ chromosomes.
☐ mitochondria.
☐ Golgi apparatus.
☐ centrioles.

27. The action potential in a nerve is initiated by

☐ an influx of sodium ions across the neural membrane.

☐ an influx of potassium ions across the neural membrane.

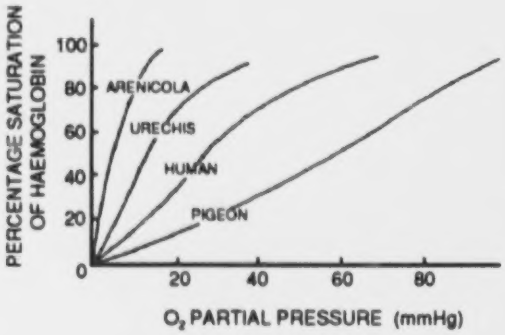
☐ the myelin sheath.

☐ the nodes of Ranvier.

☐ an outflow of sodium ions across the neural membrane.

28. The oxygen dissociation curves for several animals, in percent saturation of hemoglobin as a function of oxygen partial pressure, are shown below. *Arenicola* and *Urechis* are both species of marine worms.

Based on your knowledge, and the information provided by the graph, which of the following conclusions CANNOT be drawn?



☐ *Arenicola* and *Urechis* must share a common environment.

☐ The percentage saturation of a particular hemoglobin, at a given oxygen concentration, is dependent upon its affinity for oxygen.

☐ Humans could survive at higher altitudes than pigeons.

☐ The strength of the hemoglobin and oxygen bond must not be so strong so that it affects the unloading of oxygen in the tissues.

29. DNA controls heredity by

☐ directing the formation of genes.

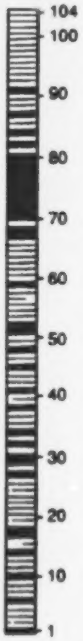
☐ ordering the construction of proteins.

☐ activating RNA chains.

☐ preventing recessive characteristics.

30. An important enzyme, involved in the hydrogen/electron transfer chain of cellular respiration, is cytochrome C oxidase.

The figure below represents a molecule of cytochrome C oxidase in which each box represents one amino acid residue. Boxes that are shaded are amino acids that are the same in each of 25 distantly related species for which the biochemical analysis has been performed. These 35 amino acid sites appear to have remained stable. The best hypothesis to account for this is that they are



☐ encoded by immutable codons.

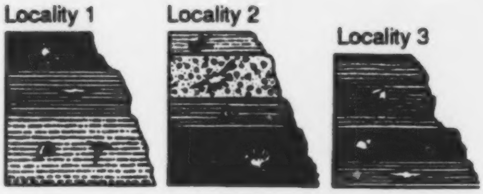
☐ unimportant for proper functioning of the enzyme.

☐ involved in maintaining the shape of the enzyme, or its interactions with the membrane.

☐ part of the active site of the enzyme.

☐ new amino acids that have been added to the enzyme since it first appeared.

31. Consider the diagrams below. It is reasonable to conclude all the following EXCEPT



☐ the fossils are most likely to be from marine deposits.

☐ the fossilization process has most likely involved rapid sedimentation.

☐ the most probable reason for the absence of certain fossils in locality 3 is erosion of the top layers.

☐ the absolute age of the fossils can be determined from the position of the strata in which they are located.

32. The pesticide DDT was used to control mosquito larvae in a 100 acre lake. One year after the application, fish species X had a DDT concentration of .01 mg/gm, while fish species Y had 0.1 mg/gm. This biological magnification implies that

☐ fish X eats fish Y.

☐ both are herbivores.

☐ both are carnivores.

☐ both are omnivores.

☐ fish Y eats fish X.

Form 5
Easy

1. The International Flat Earth Research Society measured the 60 mile Kiel Canal which links the Baltic and North Seas. They found no evidence of earth curvature. Which of the following would be the best explanation of the results?

☐ errors in measurement

☐ the earth is flat

☐ only the water in the canal remains flat

2. Which form of energy is produced when a tuning fork or a rubber band vibrates?

☐ chemical

☐ light

☐ electrical

☐ sound

3. An instrument for determining relative humidity in a room is called

☐ a humidifier.

☐ a hygrometer.

☐ a barometer.

☐ an anemometer.

☐ a thermometer.

4. Why are some areas in northern Canada that receive less than 25 cm of precipitation classified as having "humid" climates while areas in the southwestern United States that receive an equal amount of precipitation are classified as "dry"?

☐ Potential evapotranspiration is greater in the southwestern United States.

☐ The yearly distribution of precipitation is different.

☐ The vegetation of the Southwest is much different.

☐ The 500 mm isohyet falls north and east of the southwestern United States.

5. About how much of the earth's surface is covered with water?

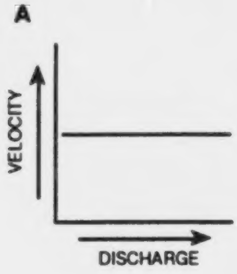
☐ 30%

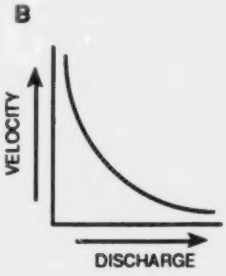
☐ 50%

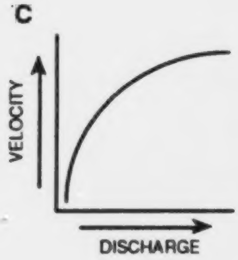
☐ 70%

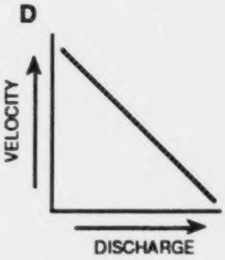
☐ 90%

6. Stream velocity and stream discharge were recorded continuously at the same location in a stream channel. Which graph below best shows the relationship between stream velocity and stream discharge at this location?







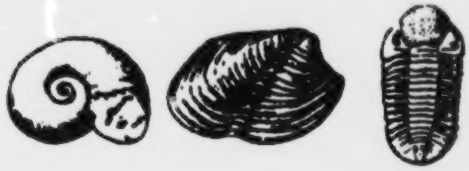


- ☐ A
- ☐ B
- ☐ C
- ☐ D

7. The frequent earthquakes on the west coast of the United States most likely are caused by

- ☐ offshore drilling for oil.
- ☐ changing tides along the coastline.
- ☐ movement of Earth's crustal plates.
- ☐ movement of large numbers of people.

8. Fossils commonly found in New York State are shown below. The environment in which these fossil organisms once lived was most likely a

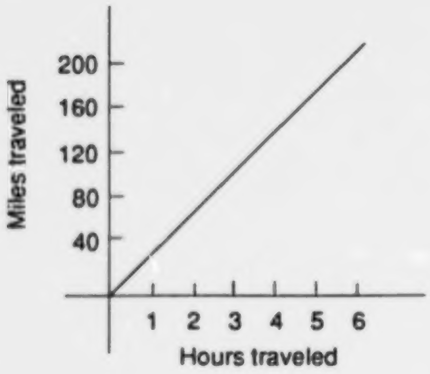


- ☐ mountain.
- ☐ sea.
- ☐ forest.
- ☐ desert.

9. The weight of an object is

- ☐ determined by its reaction to gravity as shown on a spring scale.
- ☐ the same everywhere in the universe.
- ☐ calculated by comparing it to a known mass.
- ☐ changed when heated or pounded.
- ☐ changed when melted to change the shape.

10. From the graph, what is the best estimate of the time it takes to travel 300 miles?



☐ 6 hours

☐ 9 hours

☐ 12 hours

☐ 15 hours

11. The electroscope is mainly used to detect

☐ electric potential.

☐ static electric charge.

☐ electrical resistance.

☐ moving electric charge.

☐ electric current.

12. A glass rod is given a positive charge by rubbing it with silk. The rod has become positive by

☐ gaining electrons.

☐ gaining protons.

☐ losing electrons.

☐ losing protons.

13. Handles on cooking pots usually are not made of metal because most metals are

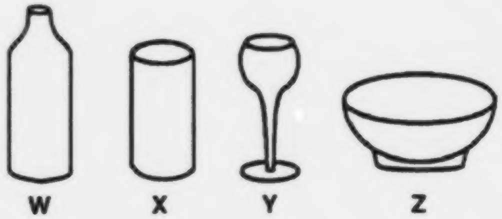
☐ expensive.

☐ likely to contract when heated.

☐ good conductors of heat.

☐ good conductors of electricity.

14. If 100 ml of water were allowed to stand in each of the containers below for one day in the sun, which would probably lose the MOST water due to evaporation?



☐ Container W

☐ Container X

☐ Container Y

☐ Container Z

15. A spoon in a glass of water appears to bend sharply at the water surface. This apparent bending is due to

☐ absorption.

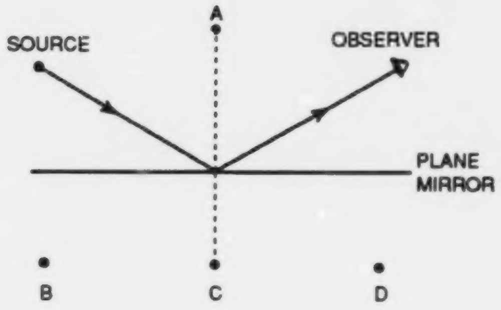
☐ color bands.

☐ interference.

☐ refraction.

☐ shadows.

16. In the diagram below, a light ray leaves a light source and reflects from a plane mirror. At which point does the image of the source appear to be located?


A
SOURCE
OBSERVER
PLANE MIRROR
B
C
D

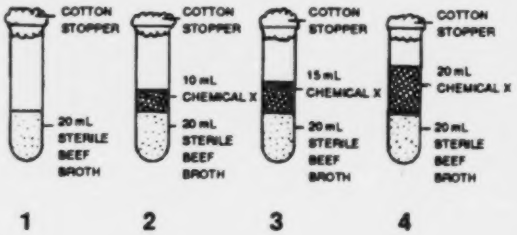
☐ A

☐ B

☐ C

☐ D

17. The following experiment tests the effect of different amounts of chemical X on the growth of bacteria. Equal amounts of the bacteria were placed in four test tubes prepared as shown below. The test tubes were left at room temperature for two weeks to allow the bacteria to multiply. Which test tube serves as the control in this experiment?


COTTON STOPPER
20 mL STERILE BEEF BROTH
COTTON STOPPER
10 mL CHEMICAL X
20 mL STERILE BEEF BROTH
COTTON STOPPER
15 mL CHEMICAL X
20 mL STERILE BEEF BROTH
COTTON STOPPER
20 mL CHEMICAL X
20 mL STERILE BEEF BROTH
1
2
3
4

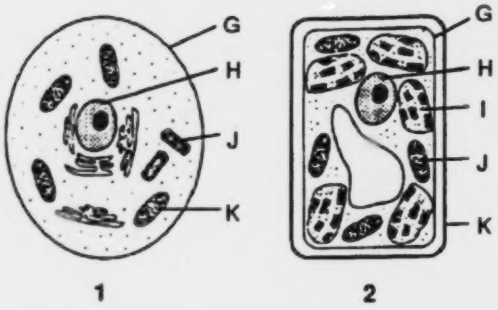
☐ 1

☐ 2

☐ 3

☐ 4

18. The diagrams below represent two different cells. Cell 2 most likely represents a plant cell due to the presence of



☐ G

☐ H

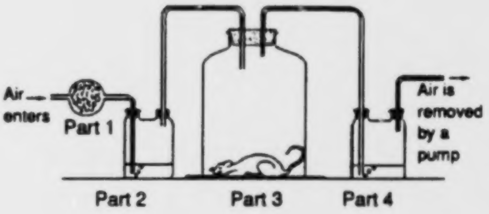
☐ J

☐ K

19. The diagram below shows apparatus which shows that an animal gives out carbon dioxide in respiration.

Part 1 contains a substance which removes carbon dioxide from the air passing through it. Parts 2 and 4 both contain a liquid which changes in appearance when carbon dioxide passes through it.

Of the following kinds of containers for the animal which one would give the quickest result?



☐ a large container

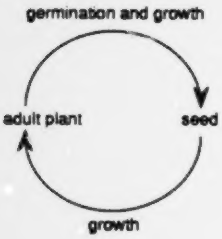
☐ a small container

☐ a container in bright light

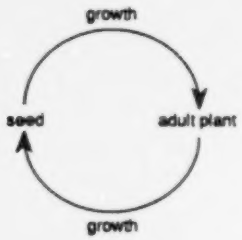
☐ a container covered with a dark cloth

☐ a container in which the air is kept moist by means of a wet cotton ball

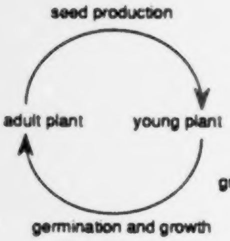
20. Which of the following diagrams is the best representation of a flowering plant life cycle?


germination and growth
adult plant
seed
growth

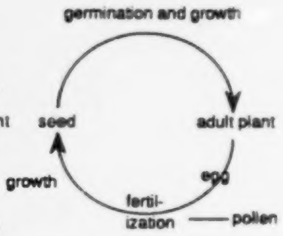
A


growth
seed
adult plant
growth

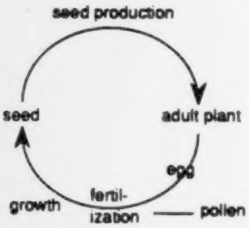
B


seed production
adult plant
young plant
germination and growth

C


germination and growth
seed
adult plant
growth
egg
fertil-
ization
pollen

D


seed production
seed
adult plant
egg
growth
fertil-
ization
pollen

E

☐ A

☐ B

☐ C

☐ D

☐ E

21. On the average, in human females, the egg is released how many days after menstruation begins?

☐ 2 days

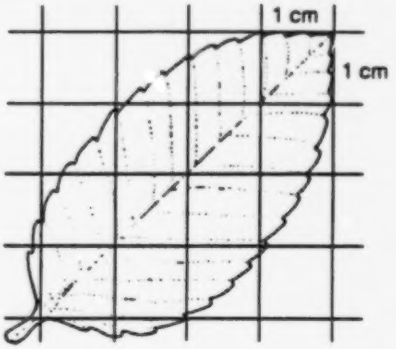
☐ 9 days

☐ 14 days

☐ 20 days

☐ 24 days

22. What is the best estimate of the surface area of the leaf shown below?



☐ 1 cm^2

☐ 2 cm^2

☐ 12 cm^2

☐ 10 cm^2

☐ 14 cm^2

23. Sharks and humans are classified in the same phylum because they both have

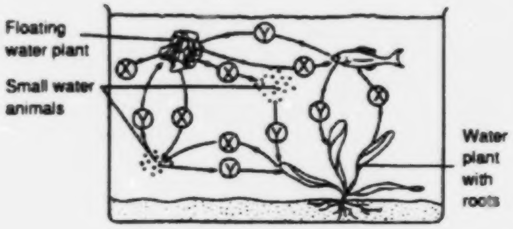
☐ jointed appendages.

☐ a dorsal nerve cord.

☐ a hollow body cavity.

☐ segmented body walls.

24. The diagram below shows an example of interdependence among aquatic organisms. During the day the organisms either use up or give off (X) or (Y) as shown by the arrows. Choose the right answer for (X) and (Y) from the alternatives below.



☐ (X) is oxygen and (Y) is carbon dioxide.
☐ (X) is oxygen and (Y) is carbohydrate.
☐ (X) is nitrogen and (Y) is carbon dioxide.
☐ (X) is carbon dioxide and (Y) is oxygen.
☐ (X) is carbon dioxide and (Y) is carbohydrate.

25. In the Periodic Table, elements with similar properties are grouped in

☐ horizontal rows.
☐ vertical columns.
☐ periods.
☐ diagonal rows.

26. Which is the atomic number of an atom with six valence electrons?

☐ 6
☐ 8
☐ 10
☐ 12

27. If a blue-black color is produced when iodine is placed on a sample of food, the food must contain

☐ proteins.
☐ minerals.
☐ starches.
☐ vitamins.

28. The equation:

$Ba(OH)_2 + H_2SO_4 \rightarrow BaSO_4 + 2H_2O$

represents

☐ a neutralization reaction.
☐ an oxidation-reduction reaction.
☐ a combustion reaction.
☐ a decomposition reaction.

29. The amount of mass per unit volume of a substance is referred to as its

☐ density.
☐ solubility.
☐ malleability.
☐ state.

30. Margaret lives in an area where the water is very hard because of dissolved calcium salts. When soap is added to the water, the calcium combines with the soap to form a white scum on the water, no suds are formed, and the soapy water does not get clothes clean enough.

Which one of the following actions could Margaret take to help to help make the water clean better?

☐ Use less soap so there will be less soap scum.

☐ Agitate the clothes in the soapy water to break up the soap scum.

☐ Keep adding soap until the soapy water will form soap suds.

☐ Add more soap, but not so much that soap suds form.

31. Diamond and graphite have the same chemical composition but very different physical properties because

☐ they differ in electrical conductivity.

☐ they are different colors.

☐ they scatter light differently.

☐ their crystal structures are different.

32. The data table below shows the temperatures in four containers. Each container holds 5 grams of the same substance. The melting point of this substance is 45°C. In which container is the substance in the solid phase?

Container	Temperature
1	30°C
2	50°C
3	80°C
4	100°C

☐ 1
☐ 2
☐ 3
☐ 4

Form 5
Intermediate

1. Which one of the following men pioneered the use of the astronomical telescope?

☐ Copernicus

☐ Galileo

☐ Kepler

☐ Brahe

☐ Newton

2. If the Earth did not rotate on its axis, yet continued to revolve around the Sun, a location on the Earth would have

☐ 8 months of darkness and 4 months of daylight.

☐ 6 months of daylight and 6 months of darkness.

☐ no days or nights.

☐ 8 months of daylight and 4 months of darkness.

3. The type of climate for a location can be determined by comparing the yearly amounts of

☐ precipitation and potential evapotranspiration.

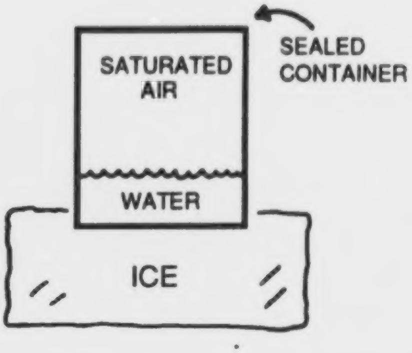
☐ soil storage and potential evapotranspiration.

☐ precipitation and infiltration.

☐ change in soil storage and stream discharge.

4. The diagram below shows a sealed container holding liquid water and clean air saturated with water vapor. (Relative humidity is 100%.) The container has been placed on a block of ice to cool.

Which statement best explains why a cloud has not formed in the sealed container?



☐ The air in the container is above the freezing point.

☐ The ice is cooling the water in the container.

☐ The air in the container lacks condensation nuclei.

☐ The water in the container is still evaporating.

5. Which of the following is NOT an effect of an El Niño (abnormally warm ocean current that occurs close to the shore)?

☐ More earthquakes occur near the shore.

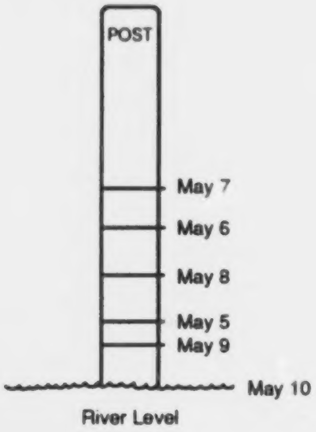
☐ The normal food chain is disrupted.

☐ The temperature of the water increases.

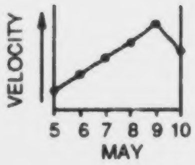
☐ Ocean plants and animals are found beyond their normal ranges.

6. The diagram below shows a post set in the streambed of a river. The river levels between May 5 and May 10 were recorded on the post by an observer at noon each day.

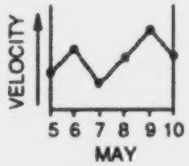
Which graph shows the probable stream current velocity that occurred during this same time period?


POST
May 7
May 6
May 8
May 5
May 9
May 10
River Level

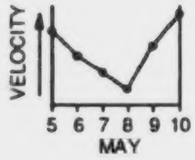
W



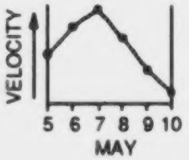
Y



X



Z



☐ W

☐ X

☐ Y

☐ Z

7. The frequent earthquakes on the west coast of the United States most likely are caused by

☐ offshore drilling for oil.

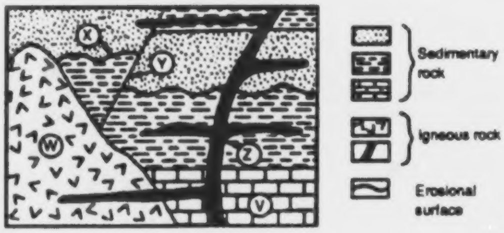
☐ changing tides along the coastline.

☐ movement of Earth's crustal plates.

☐ movement of large numbers of people.

8. The geologic cross section below represents a portion of the Earth's crust.

Which geologic event occurred last?


X
Y
W
Z
V
Sedimentary rock
Igneous rock
Erosional surface

☐ the formation of rock W

☐ the erosion of surface X

☐ the faulting along line Y

☐ the intrusion of rock Z

9. What are the correct dimensions and unit for work? (M=mass, L=length, T=time)

☐ $\frac{ML}{T}$ joules

☐ $\frac{ML}{T^2}$ joules

☐ $\frac{ML^2}{T^2}$ joules

☐ $\frac{ML}{T}$ watts

☐ $\frac{ML^2}{T^2}$ watts

10. A rock is dropped from a tall building where $g = 10\ \text{m/s}^2$. After falling for three seconds its speed will be closest to

☐ 3.0 m/s

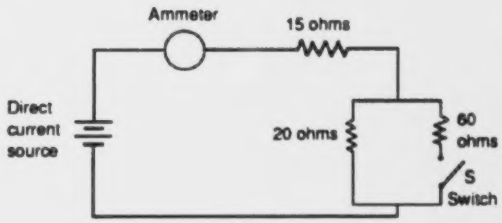
☐ 10 m/s

☐ 13 m/s

☐ 30 m/s

☐ 45 m/s

11. The diagram below represents an electric circuit. When the switch S is open the reading on the ammeter A is 2.0 amperes. When the switch is closed, what happens to the reading on the ammeter?



☐ It halves.

☐ It decreases slightly.

☐ It remains the same.

☐ It increases slightly.

☐ It doubles.

12. Experiments show that cathode rays are deflected by a magnetic field. The most reasonable inference from this observation is that cathode rays

☐ possess kinetic energy.

☐ produce X rays.

☐ travel in straight lines.

☐ carry a charge.

☐ travel at the speed of light.

13. Which of the following materials BEST conducts heat?

☐ a piece of wood

☐ a copper penny

☐ a glass of water

☐ the air in a room

☐ a plastic rod

14. A certain machine is said to be 50 percent efficient. What does this mean?

☐ The machine is not useful for the task performed.

☐ The machine operates with no loss of energy 50 percent of the time.

☐ 50 percent of the work put into the machine is returned as useful work done.

☐ 50 percent of the energy put into the machine is destroyed.

15. A spoon in a glass of water appears to bend sharply at the water surface. This apparent bending is due to

☐ absorption.

☐ color bands.

☐ interference.

☐ refraction.

☐ shadows.

16. A narrow beam of monochromatic light shines on a plate of glass with plane parallel surfaces. The index of refraction of the glass is 1.6. The sines of several angles are given in the table below. The angle of incidence of the light is 30°. The angle of emergence of the light from the glass is

Angle	Sine
18°	0.309
30°	0.500
48°	0.743
60°	0.866
72°	0.951

☐ 18°

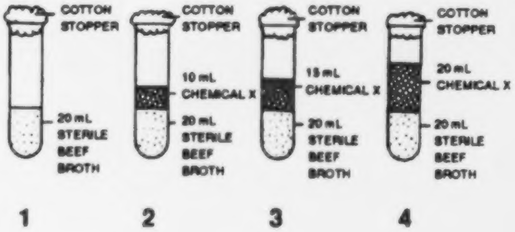
☐ 30°

☐ 48°

☐ 60°

☐ 72°

17. The following experiment tests the effect of different amounts of chemical X on the growth of bacteria. Equal amounts of the bacteria were placed in four test tubes prepared as shown below. The test tubes were left at room temperature for two weeks to allow the bacteria to multiply. Which test tube serves as the control in this experiment?


COTTON STOPPER
20 mL STERILE BEEF BROTH
1
COTTON STOPPER
10 mL CHEMICAL X
20 mL STERILE BEEF BROTH
2
COTTON STOPPER
15 mL CHEMICAL X
20 mL STERILE BEEF BROTH
3
COTTON STOPPER
20 mL CHEMICAL X
20 mL STERILE BEEF BROTH
4

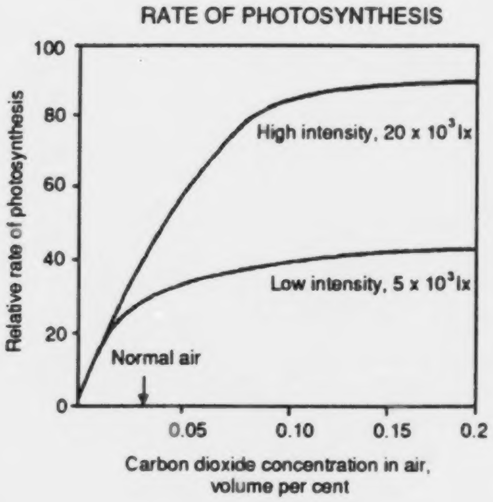
☐ 1

☐ 2

☐ 3

☐ 4

18. The figure below illustrates that



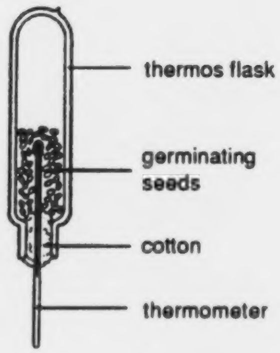
☐ light is the limiting factor in the rate of photosynthesis.

☐ an increase in carbon dioxide concentration will decrease the rate of photosynthesis.

☐ only the light reactions of photosynthesis are taking place.

☐ carbon dioxide does not affect the rate of photosynthesis.

19. The apparatus shown below is used to demonstrate the release of energy by germinating seeds. How could you show for sure that the seeds release energy during germination? By repeating the experiment, and putting in the thermos flask:



☐ another set of germinating seeds to check your results

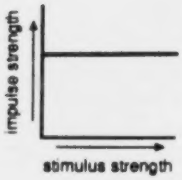
☐ some dead seeds

☐ twice as many germinating seeds as before

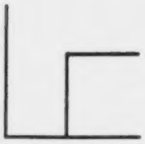
☐ some dead things such as stones

☐ some small live animals

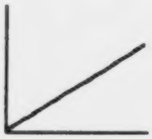
20. Which graph in the figure below best illustrates the relationship between the strength of the stimulus to an isolated neuron and the maximum height of the action potential which is caused by the stimulus?



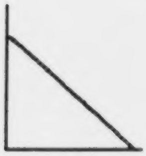
1



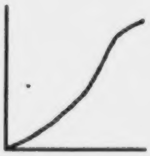
2



3



4



5

☐ 1
☐ 2
☐ 3
☐ 4
☐ 5

21. In which of the following do chromosomes NOT occur in homologous pairs?

☐ somatic cells
☐ body cells
☐ fertilized cells
☐ gametes
☐ zygotes

22. As in mammals the sex of birds is determined by a pair of chromosomes, however in birds males are ZZ, while females are ZW. If this is the case then it is true to say that characteristics which are inherited as sex-linked recessive in birds will not

☐ be expressed in the female if present on the Z chromosome.

☐ need to be homozygous in the male genotype to show up phenotypically.

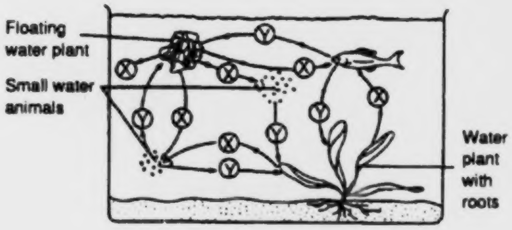
☐ mean that male birds can be carriers, and not show a sex-linked character phenotypically.

☐ result in both male and female birds having the same chance to have their sex-linked characters expressed phenotypically.

23. In the past decade, which of the following has NOT been a major cause of the increase in the world's population?

☐ longer life span
☐ lower infant mortality
☐ increase in the number of births
☐ improved sanitation
☐ modern preventative medicine

24. The diagram below shows an example of interdependence among aquatic organisms. During the day the organisms either use up or give off (X) or (Y) as shown by the arrows. Choose the right answer for (X) and (Y) from the alternatives below.



☐ (X) is oxygen and (Y) is carbon dioxide.
☐ (X) is oxygen and (Y) is carbohydrate.
☐ (X) is nitrogen and (Y) is carbon dioxide.
☐ (X) is carbon dioxide and (Y) is oxygen.
☐ (X) is carbon dioxide and (Y) is carbohydrate.

25. In the Periodic Table, elements with similar properties are grouped in

☐ horizontal rows.
☐ vertical columns.
☐ periods.
☐ diagonal rows.

26. Given an atom with the electron configuration $1s^2 2s^2 2p^3$, how many orbitals are completely filled?

☐ 1
☐ 2
☐ 3
☐ 4

27. Which is the most likely pH for a solution of a weak acid?

☐ 1
☐ 5
☐ 11
☐ 14

28. The equation:

$Ba(OH)_2 + H_2SO_4 \rightarrow BaSO_4 + 2H_2O$

represents

☐ a neutralization reaction.
☐ an oxidation-reduction reaction.
☐ a combustion reaction.
☐ a decomposition reaction.

29. Magnesium chloride is 25.6% magnesium (Mg) and 74.4% chlorine (Cl), by mass. Which of the following statements is correct?

☐ 24.3 g Mg combine with 35.5 g of Cl to form 59.8 g of magnesium chloride.
☐ 25.6 g Mg combine with 74.4 g of Cl to form 100 g of magnesium chloride.
☐ 25.6 mol of Mg combine with 74.4 mol of chlorine.
☐ One mole of magnesium atoms combines with one mole of chlorine atoms.

30. Which is the expression for the free energy change of a chemical reaction?

☐ $\Delta H = \Delta G - T\Delta S$
☐ $\Delta G = \Delta S - T\Delta H$
☐ $\Delta G = \Delta H - T\Delta S$
☐ $\Delta S = \Delta G - T\Delta H$

31. Which compound in the solid state has a high melting point and conducts electricity when it is liquefied?

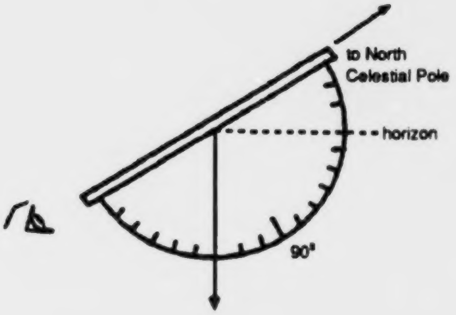
- ☐ carbon dioxide
- ☐ silicon dioxide
- ☐ hydrogen chloride
- ☐ potassium chloride

32. What is the hydroxide ion concentration of a solution that has a hydronium ion concentration of 1×10^{-9} mole per liter at 298 K?

- ☐ 1×10^{-5} mole per liter
- ☐ 1×10^{-7} mole per liter
- ☐ 1×10^{-9} mole per liter
- ☐ 1×10^{-14} mole per liter

Form 5
Difficult

1. The diagram below represents a simple sextant, which is pointing directly at the North Celestial Pole. What is the latitude of the observer?



☐ 30°N

☐ 60°N

☐ 90°N

☐ 120°N

2. An astronaut on earth has a mass of 80 kg.

What is the force of gravity on the astronaut at a distance of one earth radius above the surface of the earth? ($g = 10$ m/s^2)

☐ 800 N

☐ 400 N

☐ 200 N

☐ 40 N

☐ 20 N

3. The type of climate for a location can be determined by comparing the yearly amounts of

☐ precipitation and potential evapotranspiration.

☐ soil storage and potential evapotranspiration.

☐ precipitation and infiltration.

☐ change in soil storage and stream discharge.

4. Some parts of Alaska that receive 25 centimeters of annual precipitation are classified as humid climates. Why would areas in California with an equal annual precipitation be classified as arid?

☐ The vegetation in the California areas is much different.

☐ The total hours of daylight in a year is greater in these parts of Alaska.

☐ The yearly distribution of the precipitation in the two states is different.

☐ The potential for evaporation and transpiration is much greater in the California areas.

5. Which statement best describes the general ocean circulation patterns in the Northern and Southern Hemispheres?

☐ Ocean currents are deflected to the left in the Northern Hemisphere and to the right in the Southern Hemisphere.

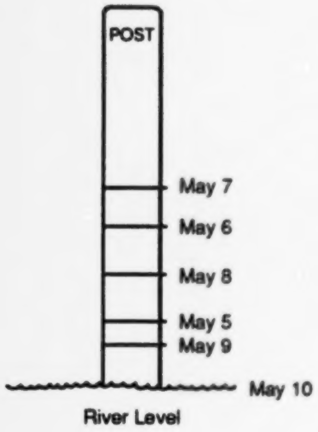
☐ Ocean currents are deflected to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.

☐ All ocean currents run parallel to the equator.

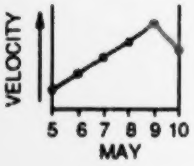
☐ Ocean currents have identical circulation patterns in both hemispheres.

6. The diagram below shows a post set in the streambed of a river. The river levels between May 5 and May 10 were recorded on the post by an observer at noon each day.

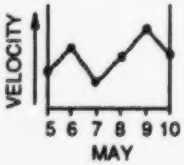
Which graph shows the probable stream current velocity that occurred during this same time period?



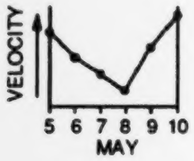
W



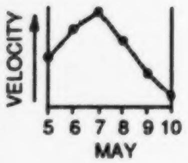
Y



X



Z



☐ W

☐ X

☐ Y

☐ Z

7. What is the best evidence that North America and Europe are still drifting apart?

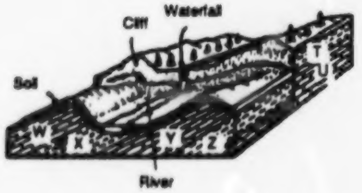
☐ a magnetic pole on one of the continents

☐ land sediments on the continental shelf

☐ measurements of distance made across the mid-Atlantic ridge

☐ deep ocean trenches off the east coast of the United States and the west coast of Spain

8. In the diagram, rock layer W appears to be



☐ younger than soil 1.

☐ more resistant to weathering than rock layer X.

☐ made of a different material than rock layer Y.

☐ the result of a lava flow.

9. The area under a velocity-time graph represents

☐ acceleration.

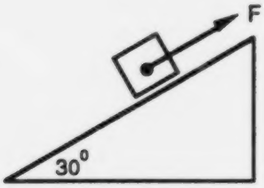
☐ change in acceleration.

☐ speed.

☐ change in velocity.

☐ displacement.

10. An object of mass 10 kg is to be held at rest on a flat surface which is inclined at 30° to the horizontal. Assume that there are no frictional forces between the object and the inclined surface. What is the value of the minimum force F acting parallel to the surface which is needed to prevent the object from sliding down the inclined surface?



Some of this information may be useful:

$\sin 30^0 = 0.50$ $\sin 60^0 = 0.87$

$\cos 30^0 = 0.87$ $\cos 60^0 = 0.50$

Acceleration due to gravity $g = 9.8$ m/sec^2

☐ 10 N

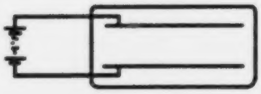
☐ 49 N

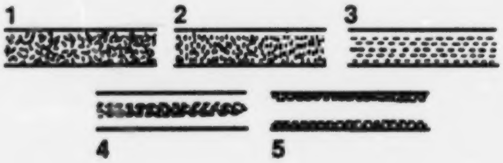
☐ 85 N

☐ 98 N

☐ 196 N

11. Seeds floating in oil are often used to show the direction of electric fields. Two metal plates were placed in a shallow container of oil, and alfalfa seeds were scattered onto the oil in the region between the plates. The two plates were charged by attaching a battery as shown in the figure below. Which of the diagrams (1,2,3,4,or 5) best shows the arrangement of the seeds after the plates were charged?





☐ 1

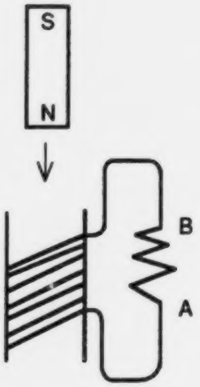
☐ 2

☐ 3

☐ 4

☐ 5

12. If a bar magnet is dropped through a hollow coil as shown, what current will be momentarily induced in the circuit?



☐ Electron flow from A to B.

☐ Electron flow from B to A.

☐ No electron flow in the circuit.

☐ Electron flow from A to B as the magnet enters the coil and from B to A as it leaves the coil.

13. In fluids the Bernoulli effect may be observed when, at two points near each other, there is a difference in

☐ streamlining.

☐ density.

☐ velocity.

☐ turbulence.

☐ direction of flow.

14. A certain machine is said to be 50 percent efficient. What does this mean?

☐ The machine is not useful for the task performed.

☐ The machine operates with no loss of energy 50 percent of the time.

☐ 50 percent of the work put into the machine is returned as useful work done.

☐ 50 percent of the energy put into the machine is destroyed.

15. Light can be polarized because

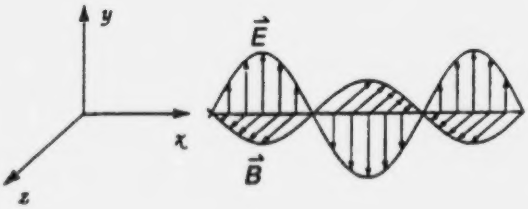
☐ it is a transverse wave.

☐ it is a longitudinal wave.

☐ it is a particle.

☐ it is an electromagnetic wave.

16. The diagram shows the directions of the electric and magnetic fields in an electromagnetic wave. What is the direction of motion of the wave?



☐ x-direction

☐ y-direction

☐ z-direction

☐ Perpendicular to x and to y

17. In paper chromatography, the larger the R_f value of the solute, the

☐ greater its attraction to the solvent relative to its attraction to the paper.

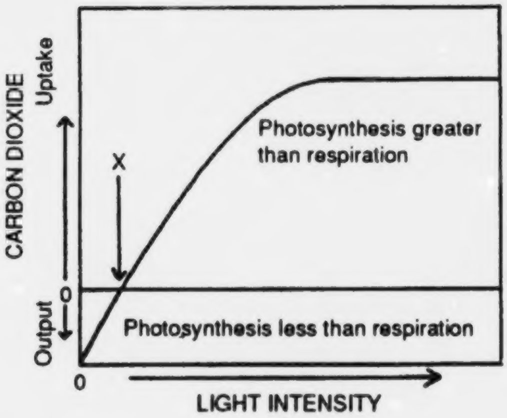
☐ greater its attraction to the paper, relative to its attraction to the solvent.

☐ less dense is the substance.

☐ more substance is dissolved in the solvent.

☐ more saturated the atmosphere is with solvent.

18. The graph below shows the effect of light intensity on the uptake of carbon dioxide by leaves. Which of the following statements is NOT supported by the graph below.



☐ Above point X, carbon dioxide uptake increases and then reaches a plateau.

☐ Below point X, there would be no photosynthesis since carbon dioxide is an output.

☐ At point X, the rate of photosynthesis equals the rate of respiration.

☐ With increasing light intensity, photosynthesis increases up to a certain level.

19. Which of the following substances would give a positive test with Benedict's solution?

☐ Cellulose

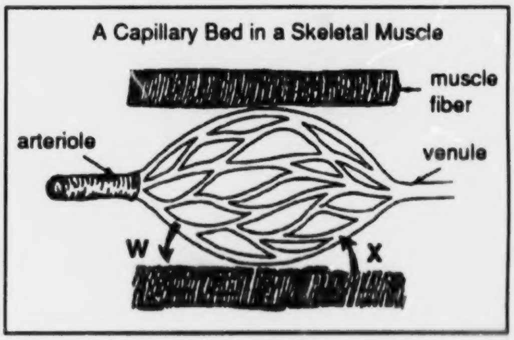
☐ Starch

☐ Fat

☐ Protein

☐ Glucose

20. In the diagram below the substance that will move in GREATEST quantity in the directions of BOTH Arrow W and Arrow X is



☐ water.

☐ oxygen.

☐ glucose.

☐ carbon dioxide.

21. In which of the following do chromosomes NOT occur in homologous pairs?

☐ somatic cells

☐ body cells

☐ fertilized cells

☐ gametes

☐ zygotes

22. Radiation causes a gene mutation in a diploid somatic cell undergoing mitosis. What would be the result of this event?

☐ The entire species will be affected.

☐ The mutation will become part of the gene pool of successive generations.

☐ Future generations will not be affected.

☐ The gametes will be affected.

☐ In time, all neighboring cells will be affected.

23. Nitrogen gas returns to the atmosphere by the action of

☐ nitrogen fixing bacteria.

☐ denitrifying bacteria.

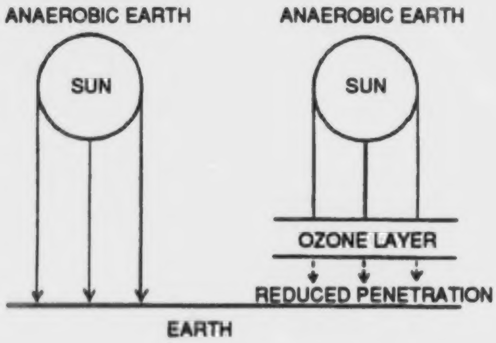
☐ nitrifying bacteria.

☐ nitrate fertilizers.

☐ ammonia.

24. Approximately 3,000 million years ago, during the Precambrian era, the Earth's atmosphere contained very little oxygen. During this time, anaerobic organisms could survive, but were confined to aquatic habitats. As the concentration of atmospheric oxygen increased, it became possible for organisms to invade the land and respire aerobically. Their cells were protected by the ozone (O_3) layer from deadly ultraviolet rays which would have made life on land impossible for anaerobes.

It is now believed that the effectiveness of the ozone layer is once again being reduced due to the use of various chemicals in our environment. Some consequences of this may include all of the following EXCEPT



☐ a greater chance of survival of aquatic than terrestrial organisms.

☐ increased cell mutation rates.

☐ a greater chance of survival for anaerobes compared with aerobic organisms.

☐ significant evolutionary changes in species during the next 3,000 million years.

25. Relative atomic masses are

☐ fixed in comparison to oxygen.

☐ weighted averages of isotopic masses.

☐ always expressed in whole numbers .

☐ averages of allotropic masses.

26. The valence electron configuration in atoms of element X is $2s^2\ 2p^4$ and in those of element Z is $4s^2\ 4p^5$. The probable empirical formula for the compound formed from these elements is

☐ XZ
☐ X_2Z
☐ XZ_2
☐ X_2Z_3

27. 25.0 mL portions of 0.10 mol/L solutions of H_2SO_4(aq), HCl(aq), and CH_3COOH(aq) are contained in separate, unlabeled flasks. Simple laboratory tests are to be done to identify the solutions. Which test could best identify one of the solutions?

☐ The H_2SO_4(aq) can be identified by the amount of KOH(aq) that must be added to reach an endpoint using phenolphthalein.
☐ The HCl(aq) can be identified by its reaction with magnesium metal to produce hydrogen gas.
☐ The HCl(aq) can be identified by the red color that results when methyl orange indicator is added.
☐ The CH_3COOH(aq) can be identified by its sour taste.

28. Which reaction is an oxidation-reduction reaction?

☐ $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$
☐ $AgNO_3(aq) + KI(aq) \rightarrow AgI(s) + KNO_3(aq)$
☐ $Mg(OH)_2(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + 2H_2O(l)$
☐ $Cu(s) + 4HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2NO_2(g) + 2H_2O(l)$

29. Which of the following is the correct balanced equation for the reaction of Na (sodium) and O_2 (oxygen)?

☐ $Na + O_2 \rightarrow NaO$
☐ $2Na + O_2 \rightarrow 2NaO$
☐ $4Na + O_2 \rightarrow 2Na_2O$
☐ $4Na + O_2 \rightarrow Na_4O_2$

30. If two liters of hydrogen at standard temperature and pressure (STP) are burned in one liter of oxygen at STP, how many liters of steam at STP will be produced?

☐ 1
☐ 1 1/2
☐ 2
☐ 2 1/2
☐ 3

31. What type of bonding exists between individual water molecules but does not exist between the elements hydrogen and oxygen within a molecule of water?

☐ ionic bonding
☐ hydrogen bonding
☐ covalent bonding
☐ electrovalent bonding

32. What is the hydroxide ion concentration of a solution that has a hydronium ion concentration of 1×10^{-9} mole per liter at 298 K?

☐ 1×10^{-5} mole per liter
☐ 1×10^{-7} mole per liter
☐ 1×10^{-9} mole per liter
☐ 1×10^{-14} mole per liter

Form 5
More Difficult

1. The mass of a star can be determined from

☐ Kepler's laws of motion.

☐ the inverse-square law of light.

☐ its gravitational influence on other objects.

☐ changes in luminosity with increasing density.

2. An astronaut on earth has a mass of 80 kg.

What is the force of gravity on the astronaut at a distance of one earth radius above the surface of the earth? ($g = 10$ m/s^2)

☐ 800 N

☐ 400 N

☐ 200 N

☐ 40 N

☐ 20 N

3. Which of the following instruments would be useful in warning of where a tornado may touch down?

☐ Doppler radar

☐ Weather satellite

☐ Barograph

☐ Anemometer

4. When the amount of water vapor in the air is 9 grams per cubic meter and the air temperature is 30° C, the relative humidity is 31%. When the same amount of water vapor is in air that has a temperature of 16° C, the relative humidity is 69%. Why is the relative humidity greater at the cooler temperature?

☐ In warm air, there is less evaporation than in cool air.

☐ Cool air holds less water vapor than warm air.

☐ There is less probability of rain in cool air.

☐ Warm air holds less water vapor than cool air.

☐ Warm air can hold less water vapor than cool air.

5. What is the percent by weight of dissolved minerals in sea water.

☐ 3.5%

☐ 5.0%

☐ 7.5%

☐ 10.0%

6. Which of the following is NOT explained by the geological theory of plate tectonics?

☐ sea-floor spreading at mid-ocean ridge

☐ the "Ring of Fire" volcanoes of the Pacific Basin

☐ the earthquakes of California

☐ the Great Lakes

7. Where are sedimentary rocks most frequently found?

☐ near mid-ocean ridges

☐ near recently formed volcanic mountains

☐ on continents as surface bedrock

☐ at nonsedimentary bedrock interfaces

8. Diagram I represents a map view of a stream with reference points A through E within the stream bed. Diagram II represents a geologic cross-section of the area over which the stream flows. (Assume that the volume of the stream is constant.) An observer looks downstream from a location just above point D and draws a cross-section of the stream bed at point D. Which diagram would probably best represent this cross-section?

DIAGRAM I: Top View

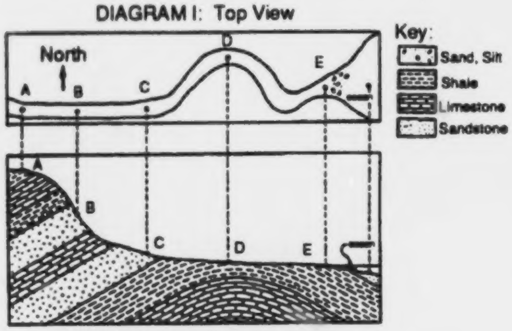
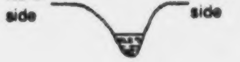

North
A
B
C
D
E
Key:
Sand, Silt
Shale
Limestone
Sandstone
A
B
C
D
E

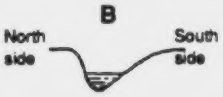
DIAGRAM II: Cross-sectional View

NOT TO SCALE

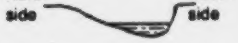
A


North side
South side

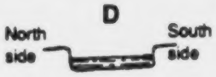
B


North side
South side

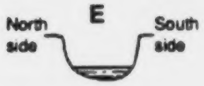
C


North side
South side

D


North side
South side

E


North side
South side

☐ A

☐ B

☐ C

☐ D

☐ E

9. A metal leaf electroscope is charged by induction with a negatively charged rod. Consider the following statements:

I. The electroscope becomes charged positively.

II. The electroscope becomes charged negatively.

III. Some electrons move from the electroscope into the ground.

IV. Some electrons move from the ground into the electroscope.

V. Some protons move from the electroscope into the ground.

Which two statements are correct?

☐ I and III.

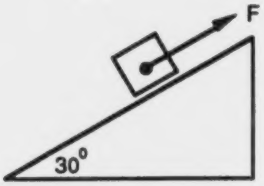
☐ I and IV.

☐ II and III.

☐ II and IV.

☐ II and V.

10. An object of mass 10 kg is to be held at rest on a flat surface which is inclined at 30° to the horizontal. Assume that there are no frictional forces between the object and the inclined surface. What is the value of the minimum force F acting parallel to the surface which is needed to prevent the object from sliding down the inclined surface?



Some of this information may be useful:

$\sin 30^\circ = 0.50$ $\sin 60^\circ = 0.87$

$\cos 30^\circ = 0.87$ $\cos 60^\circ = 0.50$

Acceleration due to gravity $g = 9.8 \text{ m/sec}^2$

☐ 10 N

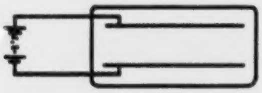
☐ 49 N

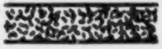
☐ 85 N

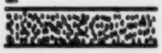
☐ 98 N

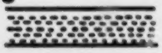
☐ 196 N

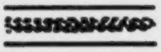
11. Seeds floating in oil are often used to show the direction of electric fields. Two metal plates were placed in a shallow container of oil, and alfalfa seeds were scattered onto the oil in the region between the plates. The two plates were charged by attaching a battery as shown in the figure below. Which of the diagrams (1,2,3,4,or 5) best shows the arrangement of the seeds after the plates were charged?

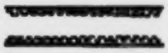


1


2


3



4


5

☐ 1

☐ 2

☐ 3

☐ 4

☐ 5

12. Through which process is magnetic force passed from a magnet to a non-magnet?

☐ conduction

☐ capacitance

☐ electrolysis

☐ induction

13. A 2 cm safety pin and a 4 cm safety pin of identical material are heated to 500 °C. Which of the following is true?

☐ There is more heat energy in the 2 cm pin.

☐ There is more heat energy in the 4 cm pin.

☐ The heat energy is equal in the two pins.

☐ The specific heat of the 4 cm pin is less.

☐ The specific heat of the 4 cm pin is twice that of the 2 cm pin.

14. The transfer of energy through empty space is known as

☐ conduction.

☐ convection.

☐ radiation.

☐ induction.

15. Visible light makes up

☐ all of the electromagnetic spectrum.

☐ half of the electromagnetic spectrum.

☐ no part of the electromagnetic spectrum.

☐ a small part of the electromagnetic spectrum.

16. If a wave vibrates 400 times per second and travels 100 meters each second, what is its wavelength?

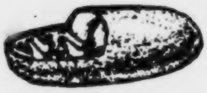
☐ 0.25 meter

☐ 2.50 meters

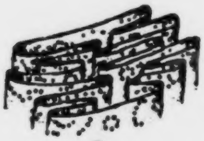
☐ 400 meters

☐ 40,000 meters

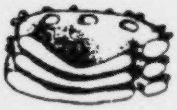
17. Which diagram represents a cell organelle that can absorb iodine stain and then be seen with the low power of a compound light microscope?



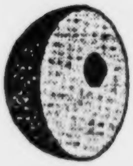
A



C



B



D

☐ A

☐ B

☐ C

☐ D

18. To maintain homeostasis, organisms use buffers to keep the pH of their body fluids within narrow limits. A biology student was investigating the control of pH by buffering. The student mixed 200 mL of a buffered solution with a pH of 4 (Solution X) with 200 mL of a base (Solution Y). After mixing, the pH of the resulting solution (Solution Z) was found to have risen to 5. Which of the following statements can be made in connection with the experiment described?

I. The pH of solution Y was 8.

II. Solution Y used up all of the buffering action of Solution X.

III. Solution Z contains a higher concentration of hydronium ions than Solution X.

IV. There were 10 times as many hydronium ions in Solution X per unit volume than there are in Solution Z.

V. Solution Z contains more hydroxyl ions per unit volume than Solution Y.

☐ II and IV only.

☐ I, II, and V only.

☐ III and IV only.

☐ II, III, and IV only.

☐ I, II, III, IV, and V.

19. A student covered one leaf of a healthy geranium plant tightly with black paper and tape. After two days in a sunny greenhouse, two leaves were removed from the plant—one that had not been covered and the one that had been. The leaves were gently boiled in alcohol to remove their chlorophyll. Iodine was applied to both leaves to detect the presence of starch. Which results would you expect?

☐ Both leaves would show the presence of starch.

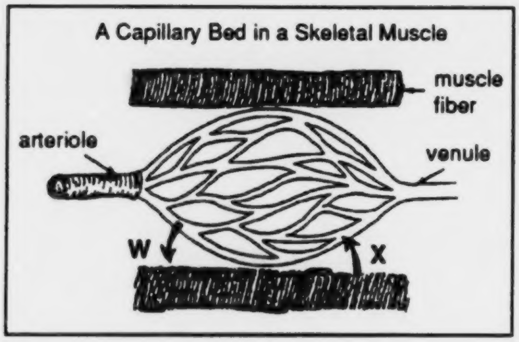
☐ Neither leaf would show the presence of starch.

☐ The covered leaf would contain more starch than the uncovered leaf.

☐ The uncovered leaf would contain more starch than the covered leaf.

☐ The iodine would react with leaf enzymes to form starch.

20. In the diagram below the substance that will move in GREATEST quantity in the directions of BOTH Arrow W and Arrow X is



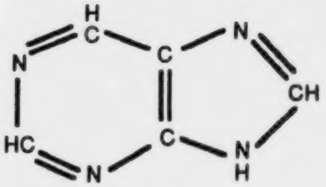
☐ water.

☐ oxygen.

☐ glucose.

☐ carbon dioxide.

21. The molecule depicted in the figure below is a(n)



☐ sugar.

☐ nucleotide.

☐ amino acid.

☐ purine.

☐ pyrimidine.

22. The precision with which a DNA molecule usually replicates is primarily due to the

☐ energy supplied when ATP undergoes a conversion to ADP.

☐ presence of genes.

☐ bonding of certain purines with certain pyrimidines.

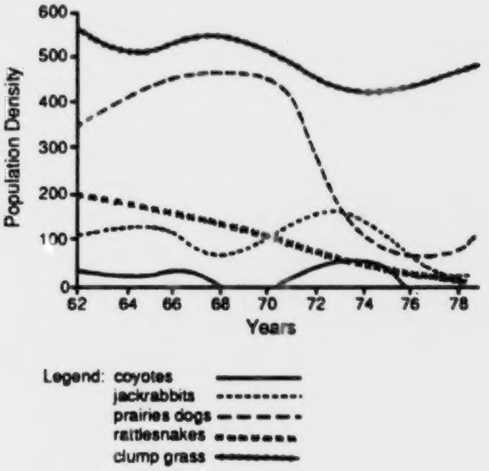
☐ spacing of the phosphate bonds in the double helix structure of the DNA molecule.

☐ the presence of only five kinds of nucleotides.

23. Unlike most plants, legumes such as clover and alfalfa, improve the soil by

- ☐ aeration.
- ☐ adding nitrates.
- ☐ breaking down soil particles.
- ☐ increasing water holding capacity.
- ☐ increasing compactability.

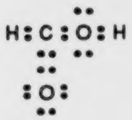
24. The following graph represents a food web observed in a desert area between 1963 and 1977. Observations were made only within an area of 10 square acres. What did the coyotes feed upon in this particular food web?



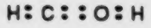
- ☐ prairie dogs
- ☐ rattlesnakes
- ☐ apparently, none of the organisms shown here
- ☐ jackrabbits
- ☐ clump grass

25. Which one of the following is an example of a correct electron dot (Lewis) structure?

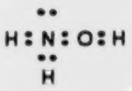
A



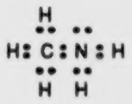
B



C



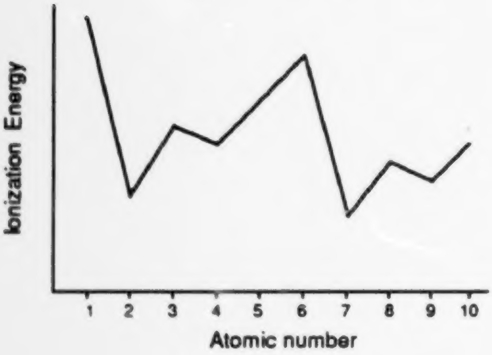
D

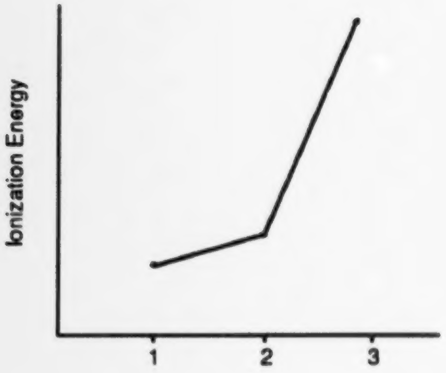


- ☐ A
- ☐ B
- ☐ C
- ☐ D

26. Given below is a list of fifteen fictitious elements and an experimentally produced graph of their first ionization energies. Which of the following elements would probably have the plot of successive ionization energies shown below?

Atomic number	Symbol
1	A
2	B
3	C
4	D
5	E
6	F
7	G
8	H





☐ element B

☐ element C

☐ element D

☐ element E

27. A student prepared the chart below for background information to be used with the two-step procedure. The observed color change was caused by

Species	Cr^{2+} (aq)	Cr^{3+} (aq)	I^- (aq)	I_2(aq)
color in aqueous solution	blue	green	colorless	brown

STEP 1: A neutral solution was prepared containing Cr^{2+} (aq), I^- (aq), and phenolphthalein.

STEP 2: Hydrochloric acid was then added to the solution in Step 1.

☐ a redox reaction.

☐ an acid-base reaction.

☐ both acid-base and redox reactions.

☐ the phenolphthalein changing color.

28. A student prepared a solution containing acetic acid and sodium acetate. If a few drops of a strong acid were added, then the

☐ pH would remain approximately constant because the acetic acid would react with the added H_3O^+(aq).

☐ pH would remain approximately constant because the acetate ion would react with the added H_3O^+(aq).

☐ pH would be raised due to the added H_3O^+(aq).

☐ pH would be 7 because the solution would be buffered.

29. Which of the following is the correct balanced equation for the reaction of Na (sodium) and O_2 (oxygen)?

☐ $Na + O_2 \rightarrow NaO$

☐ $2Na + O_2 \rightarrow 2NaO$

☐ $4Na + O_2 \rightarrow 2Na_2O$

☐ $4Na + O_2 \rightarrow Na_4O_2$

30. Which of the following operations will have the greatest effect on an equilibrium constant?

☐ Adding a catalyst at constant temperature.

☐ Increasing the pressure at constant temperature.

☐ Increasing the temperature at constant pressure.

☐ Increasing the concentration of products at constant temperature.

31. In 0.10 mol/L $CH_3COOH(aq)$,

☐ there are more molecules than ions in the solution.

☐ there are more ions than molecules in the solution.

☐ the concentration of $H_3O^+(aq)$ is significantly greater than the concentration of $CH_3COO^-(aq)$.

☐ the number of ions is equal to the number of undissociated molecules.

32. The K_{sp} for $MgCO_3$ (magnesium carbonate) is 2.5×10^{-5}. Equal volumes of the following solutions are mixed

I. 0.0002 mol/L Mg^{2+} and 0.0002 mol/L CO_3^{2-}

II. 0.002 mol/L Mg^{2+} and 0.002 mol/L CO_3^{2-}

III. 0.02 mol/L Mg^{2+} and 0.02 mol/L CO_3^{2-}

IV. 0.2 mol/L Mg^{2+} and 0.2 mol/L CO_3^{2-}

A precipitate of $MgCO_3$ forms in

☐ all of the mixtures.

☐ I and II only.

☐ II, III and IV only.

☐ III and IV only.

Form 6
Easy

1. Not all radiation given off by the Sun reaches the surface of the Earth. Why are some wavelengths of radiation not received at Earth's surface?

☐ They are reflected by clouds or absorbed by the atmosphere.

☐ They cannot travel through the vacuum of space.

☐ They are repelled by Earth's magnetic field.

☐ They are changed to other wavelengths by Earth's gravity.

2. Approximately how many degrees does the Earth rotate on its axis in 1 hour?

☐ 1°

☐ 15°

☐ 24°

☐ 360°

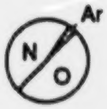
3. Our air is made up mostly of the gases listed below:

Nitrogen (N): 78%

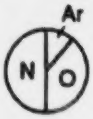
Oxygen (O): 21%

Argon (Ar): about 1%

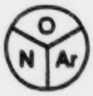
Which graph best shows these percentages?



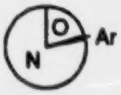
A



B



C



D

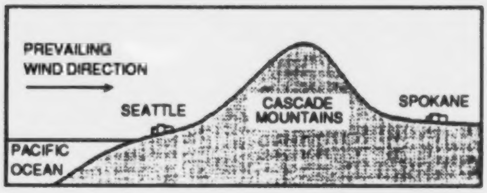
☐ A

☐ B

☐ C

☐ D

4. The diagram below shows the positions of the cities of Seattle and Spokane, Washington. Both cities are located approximately 48° North latitude, and they are separated by the Cascade Mountains. How does the climate of Seattle compare with the climate of Spokane?



- ☐ Seattle—hot and dry; Spokane—cool and humid
- ☐ Seattle–hot and humid; Spokane—cool and dry
- ☐ Seattle—cool and humid; Spokane—warm and dry
- ☐ Seattle—cool and dry; Spokane—warm and humid

5. What is the best explanation for why glaciers move to new areas?

- ☐ more snow added to the glacier, causing it to spread
- ☐ less snowfall, causing it to shrink
- ☐ colder temperatures
- ☐ gravity pulling toward the equator
- ☐ heat from the center of the earth

6. Which change in a stream system would cause the process of deposition to be dominant over erosion.

- ☐ a decrease in stream width
- ☐ a decrease in stream velocity
- ☐ an increase in stream volume
- ☐ an increase in stream slope

7. Which observation of a rock would show that it most likely is a sedimentary rock?

- ☐ It is radioactive.
- ☐ It is round.
- ☐ It contains fossils.
- ☐ It is brown.

8. A student notices many large rocks scattered in the center of a relatively flat pasture area. These probably are there because

- ☐ the farmer put them there to prevent soil erosion.
- ☐ there must have been a large explosion at one time.
- ☐ a glacier, which moved the rocks, was present in this area.
- ☐ they were formed from the earth around them clumping together.

9. A lever uses

- ☐ less force to move an object a shorter distance.
- ☐ more force to move an object a shorter distance.
- ☐ more force to move an object a greater distance.
- ☐ less force to move an object a greater distance.

10. A motor boat can travel 5 miles per hour on a still lake. If this boat travels downstream on a river that is flowing 5 miles per hour, how long will it take the boat to reach a bridge that is 10 miles downstream?

- ☐ 15 min.
- ☐ 30 min.
- ☐ 45 min.
- ☐ 60 min.
- ☐ 75 min.

11. Which one of the following instruments can be used to read directly the potential difference across a resistor in an electrical circuit?

- ☐ ammeter
- ☐ galvanometer
- ☐ ohmmeter
- ☐ potentiometer
- ☐ voltmeter

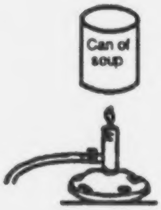
12. What is the current through a 1.20-kilowatt toaster when operating on 120 volts?

- ☐ 0.0100 ampere
- ☐ 0.0144 ampere
- ☐ 1.00 ampere
- ☐ 1.44 amperes
- ☐ 10.0 amperes

13. Why does a hot oven warm the air in a cool room?

- ☐ Heat flows from regions at higher temperatures to regions at lower temperatures.
- ☐ Insulation reduces the flow of heat.
- ☐ Cool air rises and warm air sinks.
- ☐ Heat and temperature are not the same.

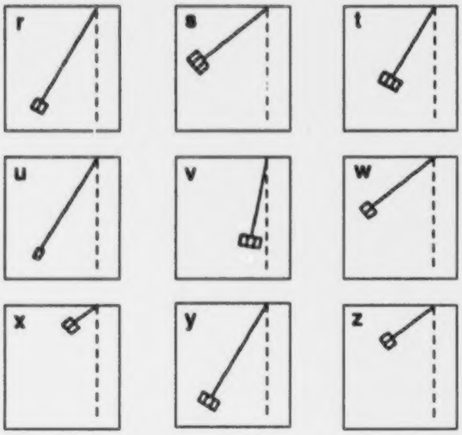
14. An unopened can of soup is heated as shown in the diagram. If the can bursts which of the following is most important in accounting for this?



- ☐ The can gets hot and expands.
- ☐ Some of the water in the soup changes to steam.
- ☐ The air in the can absorbs heat.
- ☐ The metal gets hot and starts to shrink.

15. The sketches below show different situations with a pendulum which is about to be released. You want to test this idea: the more mass the bob of the pendulum has, the more time it will take to come to rest.

Which three tests would you use?



☐ s t v

☐ w x z

☐ r u y

☐ v x y

☐ r u z

16. When a wave changes direction because it changes speed, the wave is

☐ reflected.

☐ refracted.

☐ disconnected.

☐ stopped.

17. Which of the following activities occur in a green leaf?

I. Photosynthesis

II. Respiration

III. Transpiration

IV. Growth

☐ I, II and III only.

☐ II, III and IV only.

☐ I, II and IV only.

☐ I, III and IV only.

☐ I, II, III and IV only.

18. The diagrams below represent three cells with membranes of different permeability. The dots show sugar molecules that cannot pass through the cell membrane. Into which cell(s) will the most water molecules diffuse in from the outside?

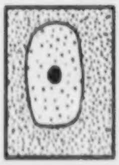


Diagram 1

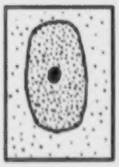


Diagram 2

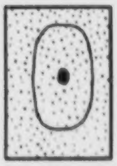


Diagram 3

☐ 1 only.

☐ 2 only.

☐ 1 and 2 only.

☐ 2 and 3 only.

☐ 1, 2, and 3.

19. Which statement best explains why a living organism in a wet mount moves into and out of focus within the field of view of a microscope?

☐ The stage clips are too tight.

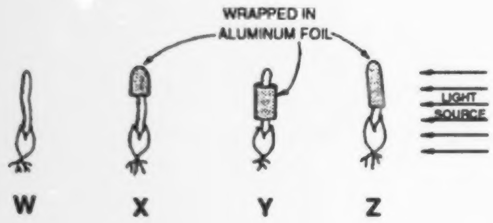
☐ The organism moves to different levels in the wet mount.

☐ The eyepiece is too far from the wet mount.

☐ The opening in the diaphragm is too large.

20. In an experiment investigating the response of plant seedlings to light, four seedlings were prepared as shown in the diagram and exposed to a light source for 36 hours.

What would be the most likely result of this experiment?



☐ Plants X and Z would bend away from the light.

☐ Only plant W would respond to light.

☐ Plants W and Y would bend toward the light.

☐ Only plants X, Y, and Z would respond to the light.

21. In animals, which condition is necessary for external fertilization?

☐ a moist environment

☐ the presence of carbon dioxide

☐ a motile egg cell

☐ the absence of light

22. Animals that have survived extinction in a changing environment have

☐ adapted.

☐ generated.

☐ hidden.

☐ not changed.

23. An explorer found a new kind of flowering plant in a remote area of the world and described it as a new species. Which of the following characteristics is most suitable to distinguish it from previously established species?

☐ its odor

☐ its root branching pattern

☐ its leaf size

☐ the type of soil it grows in

☐ the kind of flower structure it has

24. Early stages in the embryo of a fish are similar to the early stages of human and pig embryos. An explanation for this similarity is that the

☐ pig and the human occupy the same habitat, while the fish occupies a different habitat.

☐ pig and the human are more closely related to each other than to the fish.

☐ pig, human, and fish evolved from a common ancestor.

☐ pig, human, and fish had no ancestral species in common.

25. The mass of an atom depends mainly on the number of

☐ protons only.

☐ neutrons only.

☐ protons plus neutrons.

☐ protons plus electrons.

26. What is the total number of moles of atoms in 1 mole of $Ca(HCO_3)_2$?

☐ 11

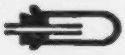
☐ 8

☐ 5

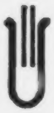
☐ 4

27. Ammonia is less dense than air and is very soluble in water. Which would be the appropriate setup for the collection vessel?

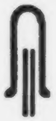
A



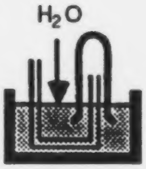
B



C



D



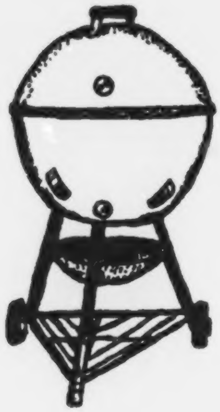
☐ A

☐ B

☐ C

☐ D

28. Materials need oxygen in order to burn. Using this idea, what would you predict will happen to a charcoal fire as the air inlets are enlarged in the charcoal burner shown here?



☐ The rate of burning will increase.

☐ The rate of burning will decrease.

☐ The rate of burning will not change.

☐ The fire will go out.

29. Which temperature represents absolute zero?

☐ 0 K

☐ 0°C

☐ 273 K

☐ 273°C

30. The periodic table of the elements shows us that an atom of oxygen is heavier than an atom of carbon.

It is also known that equal volumes of gases at equal pressure and temperature contain the same number of molecules.

From these facts, we can deduce which one of the following facts about equal volumes of the gases, oxygen (O_2), carbon dioxide (CO_2), and carbon monoxide (CO) at the same pressure and temperature?

☐ O_2 is lighter than CO_2 or CO.

☐ CO_2 is heavier than O_2 and lighter than CO.

☐ CO is lighter than CO_2 and heavier than O_2.

☐ CO_2 is heavier than O_2, and O_2 is heavier than CO.

31. What is the most common method used to separate alcohol from water?

☐ filtration

☐ distillation

☐ sedimentation

☐ electrolysis

☐ flotation

32. The air was pumped out of a can and the can collapsed. Which of the following BEST explains why this happened?

☐ Air molecules inside the can collapsed.

☐ Pumping out the air molecules weakened the can.

☐ Pumping air out of the can increased the number of air molecules around the can.

☐ The air pressure inside the can became less than the pressure outside the can.

Form 6
Intermediate

1. An astronaut standing on the middle of the far side of the Moon would

☐ never be able to see the Earth.
☐ always be able to see the Earth.
☐ always be in sunlight.
☐ always be in darkness.

2. A rocket is preparing to leave the Moon for its return trip to Earth. Compared to Earth, the escape velocity of the rocket leaving the Moon is

☐ one third as much.
☐ one sixth as much.
☐ about the same.
☐ six times as great.

3. Isotherms are lines on a map joining

☐ places with equal pressure.
☐ places with equal wind velocity.
☐ places with equal precipitation.
☐ places with equal temperature.

4. The air temperature is 10°C. Which dewpoint temperature would result in the highest probability of precipitation?

☐ 8°C
☐ 6°C
☐ 0°C
☐ −4°C

5. Which of the following affect the size of waves formed in the oceans?

☐ wind speed, constant wind direction, water temperature
☐ wind speed, air temperature, distance over which wind blows
☐ wind speed, constant wind direction, distance over which wind blows
☐ wind speed, air temperature, constant wind direction

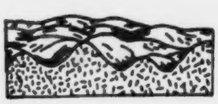
6. Which change in a stream system would cause the process of deposition to be dominant over erosion.

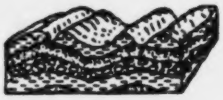
☐ a decrease in stream width
☐ a decrease in stream velocity
☐ an increase in stream volume
☐ an increase in stream slope

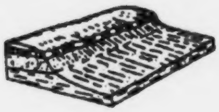
7. Which characteristics of a fossil would make it useful as an index fossil in determining the relative age of widely separated rock layers?

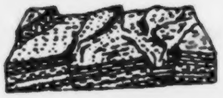
☐ a wide time range and a narrow geographic range
☐ a wide time range and a wide geographic range
☐ a narrow time range and a wide geographic range
☐ a narrow time range and a narrow geographic range

8. Which cross-sectional diagram below best represents a landscape region that resulted from faulting?


1


3


2


4

☐ 1

☐ 2

☐ 3

☐ 4

9. An object is thrown vertically upward from the earth. While it is rising

☐ its velocity and acceleration are both upward.

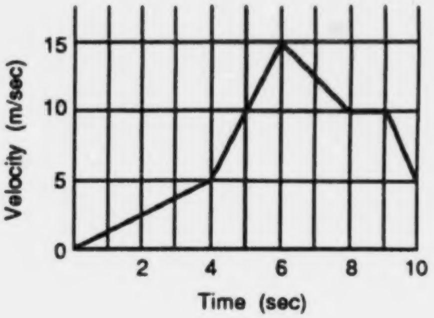
☐ its velocity and acceleration are both downward.

☐ its velocity is upward but its acceleration is downward.

☐ its velocity is downward but its acceleration is upward.

☐ its velocity and acceleration are both decreasing significantly.

10. Base your answer on the graph below which represents a velocity versus time graph for an object moving in a straight line. During which time interval did the object travel the greatest distance?



☐ 0 sec to 4 sec

☐ 4 sec to 6 sec

☐ 6 sec to 8 sec

☐ 8 sec to 9 sec

☐ 9 sec to 10 sec

11. Which one of the following meters can be used to read directly the current flowing from a photoelectric cell when light is incident on it?

☐ microammeter

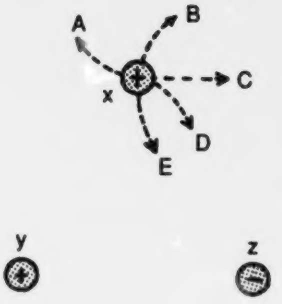
☐ photometer

☐ ohmmeter

☐ micrometer

☐ wattmeter

12. Three small spheres x, y, and z, having charges as indicated on the diagram, are the same distance apart. Spheres y and z are held in place, and sphere x is free to move on a frictionless surface. Which path will sphere x take when released?

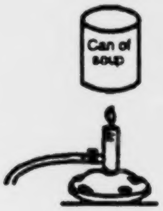


☐ A
☐ B
☐ C
☐ D
☐ E

13. When a fluid such as water passes through a constriction, the fluid's

☐ speed increases and lateral pressure decreases.
☐ speed increases and lateral pressure stays constant.
☐ speed increases and lateral pressure increases.
☐ speed decreases and lateral pressure increases.
☐ speed decreases and lateral pressure decreases.

14. An unopened can of soup is heated as shown in the diagram. If the can bursts which of the following is most important in accounting for this?



☐ The can gets hot and expands.
☐ Some of the water in the soup changes to steam.
☐ The air in the can absorbs heat.
☐ The metal gets hot and starts to shrink.

15. Light rays can be spread by using a

☐ flat mirror.
☐ flat glass plate.
☐ concave lens.
☐ telescope.
☐ microscope.

16. Newton assumed that light consists of particles. Some postulated properties of these particles are listed below. Which of these properties is needed to account for the fact that light does not slow down when it is reflected?

☐ They travel at very high speeds.
☐ They make elastic collisions.
☐ They have a very small mass.
☐ They are small compared to the spaces between them.
☐ They are affected by gravitational forces.

17. Which of the following is the best definition of anaerobic respiration?

Anaerobic respiration is

☐ a form of respiration making use of cytochromes.

☐ metabolism in the presence of ample oxygen.

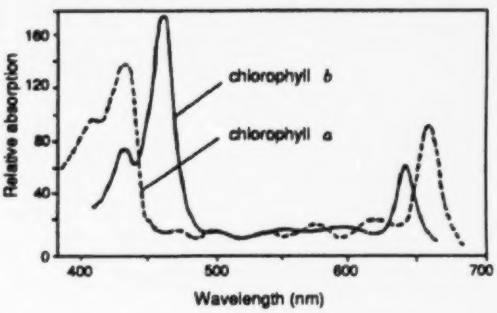
☐ cellular metabolism in the absence of oxygen.

☐ cellular metabolism with adequate oxygen.

☐ respiration by a particular species of yeast.

18. From the figure below, it can be seen that Chlorophyll *a* is more effective in absorbing light in the ____ wavelength of the visible spectrum while Chlorophyll *b* is more effective in the ____ wavelength of light.

ABSORPTION SPECTRA OF CHLOROPHYLL MOLECULES



Color (subjective)	Wavelength (nm)
Deep Red	750
Red	650
Yellow	590
Green	540
Blue	490
Violet	430

☐ red, blue

☐ violet, blue

☐ green, red

☐ blue, violet

☐ red, red

19. Which statement best explains why a living organism in a wet mount moves into and out of focus within the field of view of a microscope?

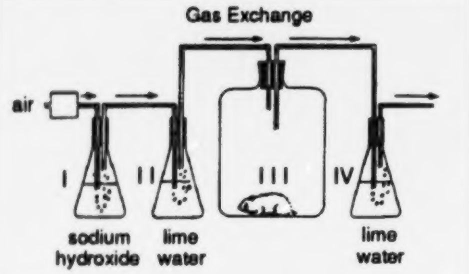
☐ The stage clips are too tight.

☐ The organism moves to different levels in the wet mount.

☐ The eyepiece is too far from the wet mount.

☐ The opening in the diaphragm is too large.

20. If air were pumped through the apparatus, one would expect to observe which results?



Note: Sodium hydroxide absorbs CO_2.
Lime water changes from clear to milky when it reacts with CO_2.

- ☐ The lime water in flasks II and IV would turn milky.
- ☐ The lime water in flasks II and IV would remain clear.
- ☐ The lime water in Flask II would turn milky while the lime water in Flask IV would remain clear.
- ☐ The lime water in Flask II would remain clear while the lime water in Flask IV would turn milky.

21. During the synthesis of proteins in cells, coded information is carried from the nucleus to the ribosomes by

- ☐ transfer RNA.
- ☐ amino acids.
- ☐ part of a strand of DNA.
- ☐ ribosomal RNA.
- ☐ messenger RNA.

22. Two dominant alleles, A and B, are on one chromosome and the two recessive alleles, a and b, occur on the second chromosome of a pair. The combination of Ab and aB occurs in the gametes by

- ☐ lack of dominance.
- ☐ sex linkage.
- ☐ crossing over.
- ☐ nondisjunction.
- ☐ dihybrid cross.

23. Much about how dinosaurs lived and died is still uncertain partly because there are no

- ☐ closely related living organisms for comparison.
- ☐ fossilized eggs or offspring for study.
- ☐ fossilized foods that could have supported dinosaurs.
- ☐ well-preserved, complete dinosaur skeletons.

24. The concept of adaptive radiation implies that

- ☐ two or more lines of descent have evolved from a common ancestor.
- ☐ humans have descended from the apes.
- ☐ all animal groups arose directly from one ancestral type.
- ☐ all well-adapted forms in evolutionary history have survived.
- ☐ only the most fit species have survived.

25. In which period are all the elements gases at 298 K and standard pressure?

☐ 1
☐ 2
☐ 3
☐ 4

26. What is the total number of moles of atoms in 1 mole of $Ca(HCO_3)_2$?

☐ 11
☐ 8
☐ 5
☐ 4

27. Which of the following is NOT a method of obtaining a sample of oxygen in the laboratory?

☐ Heating mercuric oxide
☐ Heating a mixture of potassium chlorate and manganese dioxide
☐ Adding water to sodium peroxide
☐ Electrolysis of water with direct current
☐ Adding hydrochloric acid to aluminum oxide

28. Which reaction will take place spontaneously?

☐ $Cu + 2H^+ \rightarrow Cu^{2+} + H_2$
☐ $Pb + 2H^+ \rightarrow Pb^{2+} + H_2$
☐ $2Au + 6H^+ \rightarrow 2Au^{3+} + 3H_2$
☐ $2Ag + 2H^+ \rightarrow 2Ag^+ + H_2$

29. Which temperature represents absolute zero?

☐ 0 K
☐ 0°C
☐ 273 K
☐ 273°C

30. In all chemical reactions the mass of the

☐ products is greater than the mass of reactants.
☐ reactants is greater than the mass of products.
☐ reactants always equals the mass of products.
☐ products may be more or less than the mass of reactants.

31. Gas collection by water displacement is used for gases which are

☐ colored.
☐ more dense than air.
☐ not appreciably water soluble.
☐ more dense than water.

32. As NaCl(s) dissolves according to the equation $NaCl(s) \rightarrow Na^+(aq) + Cl^-(aq)$, the entropy of the system

☐ decreases.
☐ increases.
☐ remains the same.

Form 6
Difficult

1. An astronaut standing on the middle of the far side of the Moon would

☐ never be able to see the Earth.
☐ always be able to see the Earth.
☐ always be in sunlight.
☐ always be in darkness.

2. If the altitude of the North Star is 47 degrees above the horizon, the observer's latitude is near

☐ 53 degrees north.
☐ 47 degrees north.
☐ 43 degrees north.
☐ 0 degrees.

3. In a class investigation, Ms. Juarez' students measured the dew point of the air in their classroom every ten minutes for the entire class period. They found that the dew point varied with each measurement. What would not cause this variation?

☐ different methods for measuring dew point
☐ the air conditioning going on and off
☐ boiling water in the classroom
☐ opening and closing the door to the outside

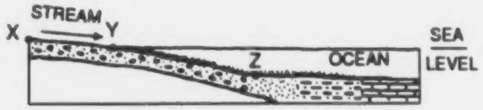
4. The air temperature is 10°C. Which dewpoint temperature would result in the highest probability of precipitation?

☐ 8°C
☐ 6°C
☐ 0°C
☐ −4°C

5. What is the primary cause of deep ocean currents?

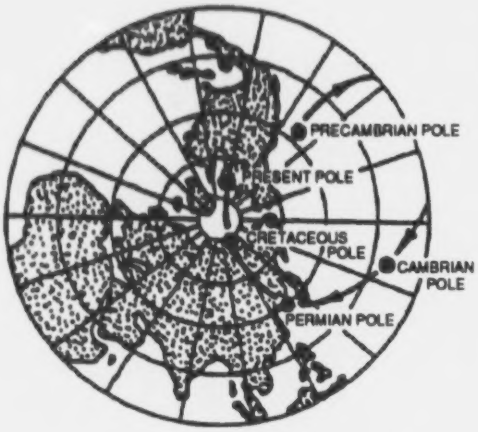
☐ winds at the ocean surface
☐ the shape of the ocean floor
☐ the rotation of the Earth
☐ water density differences within the oceans

6. The diagram below shows the pattern of deposition of stream-carried sediments on the ocean floor. If the stream discharge between X and Y increased, the most likely result would be



☐ a decrease in the amount of erosion.
☐ a decrease in the average stream velocity.
☐ an increase in the deposition of sediments between X and Y.
☐ an increase in the particle size of sediments entering the ocean.

7. The map below shows the position of the north magnetic pole at various times in the past. These positions have most likely been determined by using



☐ compass readings on various continents today.

☐ magnetic properties of rocks formed during various geologic times.

☐ seismic waves traveling through the Earth's interior.

☐ fossils found in bedrock formed during various geologic times.

8. Rock strata containing fossils of shark's teeth are found at an elevation of 3,000 meters. Which process most likely caused the shark's teeth to be located at this elevation?

☐ crustal subsidence

☐ ocean floor spreading

☐ crustal uplift

☐ continental glaciation

☐ earthquakes

9. Three statements describing motion are given below.

Which of these statements is/are correct?

I. Starting from rest, a body on earth falls 10 m in the first second.
II. In a vacuum, at a given location on earth, all objects fall with the same acceleration.
III. An object, travelling with constant acceleration, covers equal distance in equal intervals of time.

☐ II only.

☐ I and II only.

☐ I and III only.

☐ II and III only.

☐ I, II and III.

10. A certain force gives mass m_1 an acceleration of 12 m/s^2. The same force gives mass m_2 an acceleration of 3.0 m/s^2.

What acceleration would the force give to an object whose mass is the difference between m_1 and m_2?

☐ 2.4 m/s^2

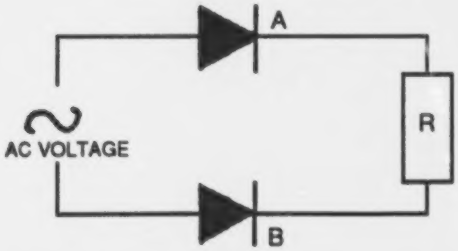
☐ 4.0 m/s^2

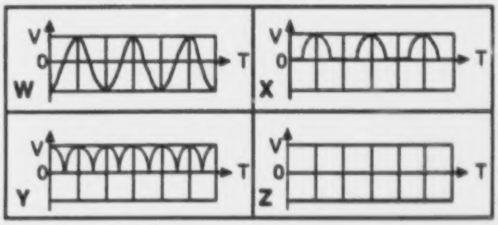
☐ 6.0 m/s^2

☐ 9.0 m/s^2

☐ The acceleration cannot be determined from the information given.

11. Which of the following graphs best shows the potential difference across R if diode B is shorted out?





V = Voltage T = Time

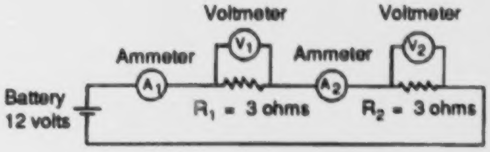
☐ W

☐ X

☐ Y

☐ Z

12. This question is based on the circuit represented by the diagram shown below. Which one of the sets of results in the table below would be observed?



Set	Ammeter A_1	Voltmeter V_1	Ammeter A_2	Voltmeter V_2
J	1 amp	6 volts	1 amp	6 volts
K	1 amp	12 volts	1 amp	12 volts
L	1 amp	6 volts	2 amps	6 volts
M	2 amps	6 volts	2 amps	6 volts
N	2 amps	12 volts	2 amps	12 volts

☐ J

☐ K

☐ L

☐ M

☐ N

13. An electron volt is the

☐ force acting on an electron moving through an electrical potential difference of one volt.

☐ force required to move an electron through a distance of one meter.

☐ energy gained by one electron moving through an electrical potential difference of one volt.

☐ energy needed to move an electron through a distance of one meter.

☐ work done when one coulomb of charge is moved through an electric potential difference of one volt.

14. According to the kinetic theory of gases, the pressure exerted by a gas is due to the change of momentum of the particles of gas as they rebound from the walls of the container. If the change of momentum is 2mv, where m is the mass of the particles and v is their average velocity, what does the theory indicate about the velocity of particles of a heavy gas, such as carbon dioxide, relative to that of a light gas, such as hydrogen, when both are at the same temperature and pressure?

☐ The average velocity does not depend upon the density of the gases.
☐ The average velocity of particles is less in the lighter gas.
☐ The particles of the heavy gas lose more of their velocity when they strike the wall.
☐ The average velocity of particels is greater in the lighter gas.

15. Light rays can be spread by using a

☐ flat mirror.
☐ flat glass plate.
☐ concave lens.
☐ telescope.
☐ microscope.

16. If a radio wave with frequency f and wavelength λ in air enters a new medium and its speed changes to two-thirds of its speed in air, then its

☐ frequency will change to 2f/3.
☐ frequency will change to 3f/2.
☐ wavelength will change to $3\lambda/2$.
☐ wavelength will change to $2\lambda/3$.

17. In the Calvin (C_3) cycle of the light-independent ("dark") reactions of photosynthesis, the immediate source of energy for the fixing of carbon dioxide is

☐ light.

☐ photolysis.

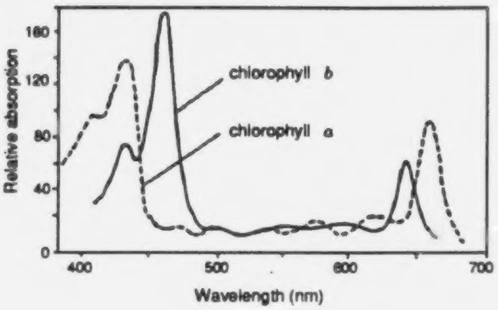
☐ water molecules.

☐ hydrogen ions.

☐ ATP.

18. From the figure below, it can be seen that Chlorophyll *a* is more effective in absorbing light in the ____ wavelength of the visible spectrum while Chlorophyll *b* is more effective in the ____ wavelength of light.

ABSORPTION SPECTRA OF CHLOROPHYLL MOLECULES



Color (subjective)	Wavelength (nm)
Deep Red	750
Red	650
Yellow	590
Green	540
Blue	490
Violet	430

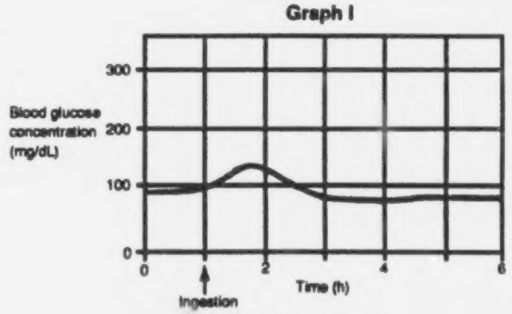
- ☐ red, blue
- ☐ violet, blue
- ☐ green, red
- ☐ blue, violet
- ☐ red, red

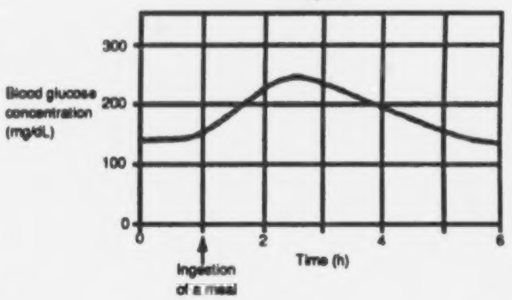
19. Methylene blue is used in microscope studies to help in the observation of

- ☐ chloroplasts of onion cells.
- ☐ iron in hemoglobin.
- ☐ nuclei in animal cells.
- ☐ photosynthesis in elodea.

20. The two graphs below show changes in blood glucose concentration in two different persons after they each ingest a meal containing 50 g of glucose. Graph I represents the normal person's blood sugar levels.

Correct interpretation of Graph II supports the hypothesis that the second person following a fast, had





- ☐ decreased levels of glucagon.
- ☐ decreased levels of insulin.
- ☐ increased levels of insulin.
- ☐ increased levels of thyroxin.

21. During translation, a transfer RNA (tRNA) molecule is associated with

☐ an amino acid, a messenger RNA molecule and a ribosome.

☐ an amino acid molecule, a DNA molecule, and a ribosome.

☐ an amino acid, a DNA molecule, and a ribosome.

☐ a DNA molecule, a messenger RNA molecule, and a ribosome.

☐ an amino acid, a ribosome, and a nucleolus.

22. If an enzyme (RNA-ase) that facilitates the breakdown of RNA were introduced into a cell, the function that would be affected first would be

☐ protein synthesis.

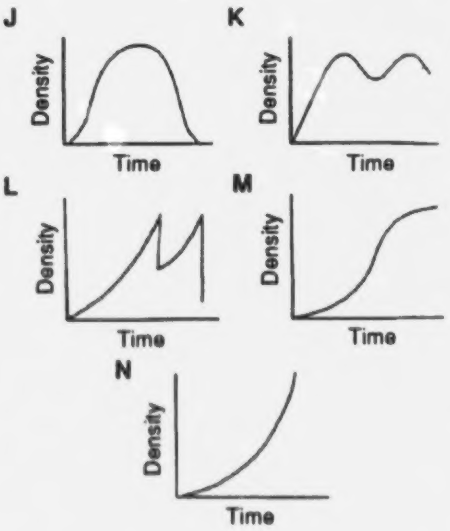
☐ replication of DNA.

☐ formation of ATP.

☐ glycolysis.

☐ breakdown of lipids.

23. Which of the graphs in the figure below, plotted on arithmetic scales, best represents the exponential growth of a population?



☐ J

☐ K

☐ L

☐ M

☐ N

24. Which one of the following statements is the best description of homologous structures?

They have a similar

☐ structure but a different embryonic origin.

☐ function but no common ancestry.

☐ structure and embryonic origin.

☐ function but a different structure.

☐ appearance and embryonic origin.

25. The sharing of electrons in bond formation always involves

☐ lower energy content for the bonded than the unbonded atoms.

☐ formation of polar molecules.

☐ shared electrons being attracted more by one atom than another.

☐ formation of positive and negative ions.

26. The following table gives the dissociation constants of four acids. Which acid is the strongest?

Formic	1.8×10^{-4}
Benzoic	6.3×10^{-5}
Acetic	1.8×10^{-5}
Carbonic	4.3×10^{-7}

☐ Acetic

☐ Benzoic

☐ Carbonic

☐ Formic

27. Identify the statement that distinguishes electrochemical cells from electrolytic cells.

☐ Electrolytic cells require an electrolyte.

☐ Electrochemical cells require a cathode and an anode.

☐ Electrolytic cells require an external power source.

☐ Electrochemical cells require a pathway so ions can move between cells.

28. A certain chemical reaction can be represented by the following equation:

$2A(g) + B(g) \rightarrow C(g)$

At a fixed temperature, the initial rate of the reaction was measured for various initial concentrations of A and B. The results are shown in the table below. The rate law expression for this reaction is

Initial concentration (mol/L)		Initial reaction rate (mol/h)
A	B	
0.50	0.50	2.0×10^{-3}
1.0	0.50	8.0×10^{-3}
1.0	1.0	8.0×10^{-3}
1.5	1.0	18×10^{-3}
1.0	1.5	8.0×10^{-3}

☐ Rate = $k[A]^2$

☐ Rate = $k[B]^2$

☐ Rate = $k[A]^2[B]^2$

☐ Rate = $k[A]\,[B]$

29. When gases combine chemically or are produced in a chemical reaction, there is always a simple whole number ratio between their

☐ masses.

☐ densities.

☐ volumes.

☐ critical temperatures.

30. The rate of the reaction represented by:

$2X(g) + Y(g) \rightarrow Z(g)$

☐ is $k\frac{[Z(g)]}{[X(g)]^2[Y(g)]}$

☐ is $k[Z(g)][X(g)][Y(g)]$

☐ is $k\frac{[X(g)]^2[Y(g)]}{[Z(g)]}$

☐ cannot be predicted from the equation

31. The best choice of indicators for the titration of a weak acid (sample) with a strong base (titrant) is

☐ bromothymol blue.

☐ phenolthalein.

☐ litmus.

☐ methyl red.

32. As NaCl(s) dissolves according to the equation $NaCl(s) \rightarrow Na^+(aq) + Cl^-(aq)$, the entropy of the system

☐ decreases.

☐ increases.

☐ remains the same.

Form 6
More Difficult

1. A "black hole" is not actually a "hole" but a(n)

- ☐ dead star.
- ☐ huge dark nebula.
- ☐ extremely small, dense star.
- ☐ magnetic force field.

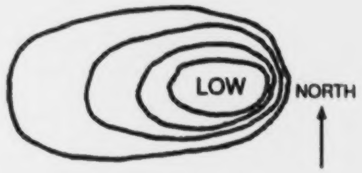
2. Which one of the following Earth-Moon-Sun positions would lead to the greatest tidal height in a particular coastal region?

- ☐ new Moon when the Earth is closest to the Sun
- ☐ new Moon when the Earth is furthest from the Sun
- ☐ first quarter Moon when the Earth is closest to the Sun
- ☐ first quarter Moon when the Earth is furthest from the Sun

3. When a sample of air is passed through an aqueous solution of calcium hydroxide, the formation of a white precipitate indicates the presence of

- ☐ oxygen.
- ☐ nitrogen.
- ☐ carbon monoxide.
- ☐ argon.
- ☐ carbon dioxide.

4. The map below shows lines of equal air pressure (isobars) around a low-pressure center in the United States. On which side of the low-pressure center will the wind speed be greatest?



- ☐ north
- ☐ south
- ☐ east
- ☐ west

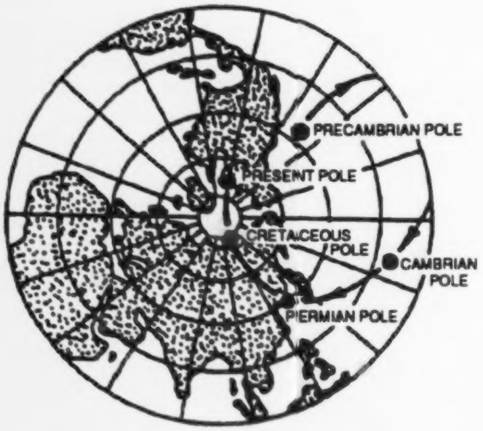
5. The surface heat of Earth is distributed by

- ☐ ocean currents.
- ☐ ocean tidal movements.
- ☐ wind waves on the ocean's surface.
- ☐ gravitation of the moon and sun.

6. The crystal structure of ice makes it

- ☐ more dense than water.
- ☐ less dense than water.
- ☐ of equal density to water.
- ☐ of uncertain density.

7. The map below shows the position of the north magnetic pole at various times in the past. These positions have most likely been determined by using



☐ compass readings on various continents today.

☐ magnetic properties of rocks formed during various geologic times.

☐ seismic waves traveling through the Earth's interior.

☐ fossils found in bedrock formed during various geologic times.

8. What does the fact that gravity is lower than expected over mountain ranges suggest about their structure?

☐ Mountain ranges must have high density roots.

☐ Mantle rocks must be nearer the surface beneath mountains.

☐ The cores of mountains have been uplifted during geologic history.

☐ Low-density rock must extend to greater depths beneath mountains than elsewhere.

9. Three statements describing motion are given below.

Which of these statements is/are correct?

I. Starting from rest, a body on earth falls 10 m in the first second.
II. In a vacuum, at a given location on earth, all objects fall with the same acceleration.
III. An object, travelling with constant acceleration, covers equal distance in equal intervals of time.

☐ II only.

☐ I and II only.

☐ I and III only.

☐ II and III only.

☐ I, II and III.

10. Ball A of mass 5 kg moving at 20 m/sec collides with Ball B of unknown mass moving at 10 m/sec in the same direction. After collision, Ball A moves at 10 m/sec and Ball B at 15 m/sec, both still in the same direction.

What is the mass of Ball B?

☐ 2 kg

☐ 6 kg

☐ 10 kg

☐ 12 kg

☐ 30 kg

11. A potential difference of 50 volts is required to operate an electrical device. The potential difference of the source is 120 volts. The table shows the primary and secondary windings for four available transformers. Which transformer is suitable for this application?

Transformer	Primary	Secondary
A	250	600
B	600	240
C	240	150
D	150	250

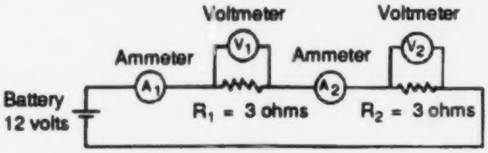
☐ A

☐ B

☐ C

☐ D

12. This question is based on the circuit represented by the diagram shown below. Which one of the sets of results in the table below would be observed?



Set	Ammeter A_1	Voltmeter V_1	Ammeter A_2	Voltmeter V_2
J	1 amp	6 volts	1 amp	6 volts
K	1 amp	12 volts	1 amp	12 volts
L	1 amp	6 volts	2 amps	6 volts
M	2 amps	6 volts	2 amps	6 volts
N	2 amps	12 volts	2 amps	12 volts

☐ J

☐ K

☐ L

☐ M

☐ N

13. Consider the following attributes and values:

I. a strong magnetic field

II. a strong negative charge

III. a strong positive charge

Cathode rays can be deflected by

☐ I only.

☐ II only.

☐ III only.

☐ I and II only.

☐ I, II and III.

14. How does the total kinetic energy in ONE liter of water at 95°C compare with the total kinetic energy of TWO liters of water at 95°C?

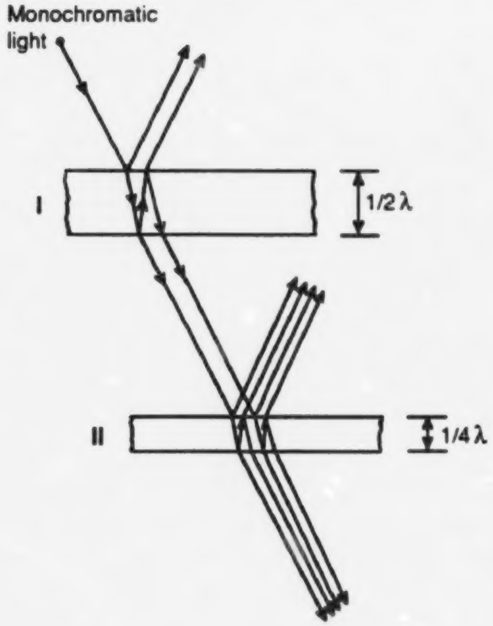
☐ The total kinetic energy of the two liter flask is less than the one liter flask.

☐ The total kinetic energy of the one liter flask is less than the two liter flask.

☐ The total kinetic energy in each of the two flasks is the same.

☐ The average kinetic energy of the two flasks cannot be compared.

15. Light from a mono-chromatic source of wavelength λ is shone through two thin films as shown in the diagram. Where will the light encounter destructive interference?



☐ I only.

☐ II only.

☐ I and II.

☐ Neither I nor II.

16. Which one of the following phenomena of light cannot be accounted for by the particle theory?

☐ pressure

☐ emission

☐ interference

☐ propagation

☐ reflection

17. The specialized function of a cell is best indicated by

☐ the size of the cell.

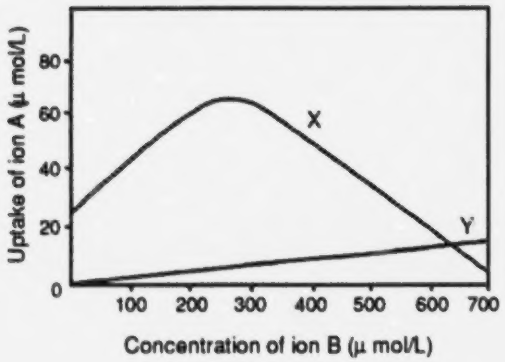
☐ the size of the nucleus.

☐ the number and type of organelles.

☐ the structure of the cell membranes.

18. The figure below shows the results of an experiment involving the uptake of two ions into living plant tissue. Uniform discs of carrot tissue were placed in a solution of ion X, and the amount of ion Y was increased during several trials. The amounts of both ions absorbed were measured in each trial. Which of the following provides a possible explanation for the results?

UPTAKE OF IONS BY PLANT TISSUE



☐ Both X and Y appear to move into the cell by diffusion.

☐ X appears to move in by active transport, Y by diffusion.

☐ Y appears to move in by active transport, X by diffusion.

☐ X appears to move into the cell by active transport, but Y does not appear to move either by diffusion or by active transport.

☐ Y appears to be diffusion, but X does not appear to move either by diffusion or by active transport.

19. A researcher ground up plants of the potato family and tested them for mercury content. The most reasonable hypothesis this researcher is testing is that

☐ greater exposure to sunlight will decrease the quantity of mercury found in these plants.

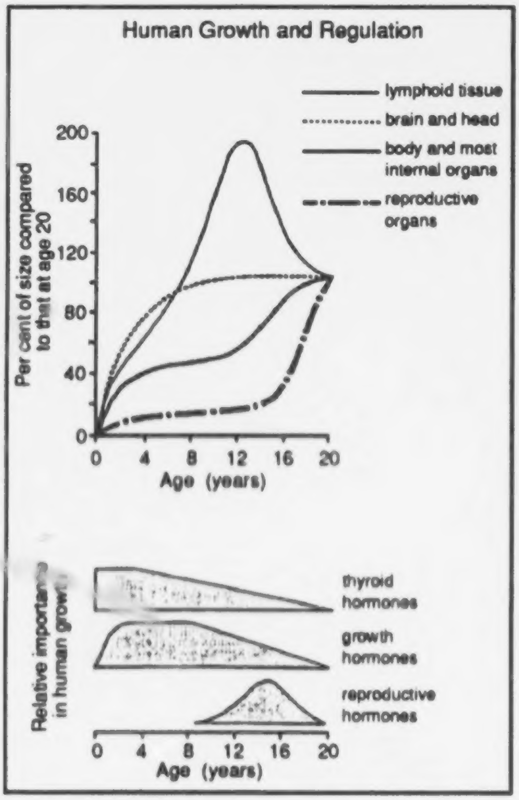
☐ leaves will contain more mercury than will roots.

☐ plants in this family do not require mercury.

☐ some species of plants in this family take up more mercury than others.

☐ increased amounts of mercury will improve the growth rate of these plants.

20. Which interpretation is BEST supported by the data shown in the graphs below?



☐ The growth "spurt" of adolescence is primarily due to increased levels of reproductive hormones.

☐ Reproductive organs must become mature before sex hormones can be produced in the body.

☐ Lymphoid tissue is used to form reproductive organs during adolescence.

☐ The function of the brain is NOT affected by reproductive hormones.

21. During translation, a transfer RNA (tRNA) molecule is associated with

☐ an amino acid, a messenger RNA molecule and a ribosome.

☐ an amino acid molecule, a DNA molecule, and a ribosome.

☐ an amino acid, a DNA molecule, and a ribosome.

☐ a DNA molecule, a messenger RNA molecule, and a ribosome.

☐ an amino acid, a ribosome, and a nucleolus.

22. A slight change in the pH of its surroundings changes the activity of an enzyme by

☐ masking its active site.

☐ breaking its peptide bonds.

☐ increasing the activation energy of the reaction.

☐ altering its 3-dimensional shape.

☐ causing it to precipitate.

23. Organisms are often classified on the basis of structural similarities. These similarities show the degree of relatedness. Which of the following groups of organisms includes those that are most closely related?

☐ spider, ant, crayfish, centipede

☐ human, bird, lizard, salamander

☐ horse, dog, cat, mouse

☐ fish, crayfish, starfish, jellyfish

☐ whale, penguin, octopus, squid

24. Which one of the following statements is the best description of homologous structures?

They have a similar

- ☐ structure but a different embryonic origin.
- ☐ function but no common ancestry.
- ☐ structure and embryonic origin.
- ☐ function but a different structure.
- ☐ appearance and embryonic origin.

25. In which group is the shape of all substances tetrahedral?

- ☐ NH_4^+, SO_4^{2-}, CCl_4
- ☐ SO_4^{2-}, SF_4, CH_4
- ☐ CCl_4, XeF_4, SO_4^{2-}
- ☐ CH_4, XeF_4, SF_4

26. Given that the Bohr relationship for determination of the energy levels in a hydrogen atom is $E_n = -\frac{1680}{n^2}$ kJ/mol and $h = 4.00 \times 10^{-13}$ kJ-s/mol the frequency (f) of light emitted in an $n = 4$ to $n = 1$ transition is (recall $E = hf$)

- ☐ $2.60 \times 10^{12}\ s^{-1}$
- ☐ $-2.60 \times 10^{12}\ s^{-1}$
- ☐ $3.94 \times 10^{15}\ s^{-1}$
- ☐ $3.94 \times 10^{15}\ s^{-1}$

27. Identify the statement that distinguishes electrochemical cells from electrolytic cells.

- ☐ Electrolytic cells require an electrolyte.
- ☐ Electrochemical cells require a cathode and an anode.
- ☐ Electrolytic cells require an external power source.
- ☐ Electrochemical cells require a pathway so ions can move between cells.

28. Equilibrium partial pressures for the reaction

$H_2(g) + I_2(g) \rightarrow 2HI(g)$

are given in the table both before and after a change was made. Which change could account for the data below?

	H_2	I_2	HI
Before	1.000 atm	0.500 atm	0.200 atm
After	0.228 atm	0.550 atm	0.100 atm

- ☐ The temperature was changed.
- ☐ I_2 was added.
- ☐ HI was removed.
- ☐ H_2 was removed.

29. If a solution has pH = 3.0, what is its hydronium ion concentration in moles per liter?

- ☐ $10^{3.0}$ m/l
- ☐ $10^{-3.0}$ m/l
- ☐ $1/10^{-3.0}$ m/l
- ☐ 3.0^{-10} m/l

30. For the reaction

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

the equilibrium constant $K = 261$ at 1000 K. At this temperature, the equilibrium constant for the reaction

$SO_3(g) \rightleftharpoons SO_2(g) + \frac{1}{2}O_2(g)$

is

- ☐ $(1/261)^2$
- ☐ $1/261$
- ☐ $(261)^2$
- ☐ $(1/261)^{\frac{1}{2}}$

31. A volume of 25.0 L of an ideal gas is at 202 kPa pressure and 300 K. At standard temperature and pressure, the volume of the gas would be

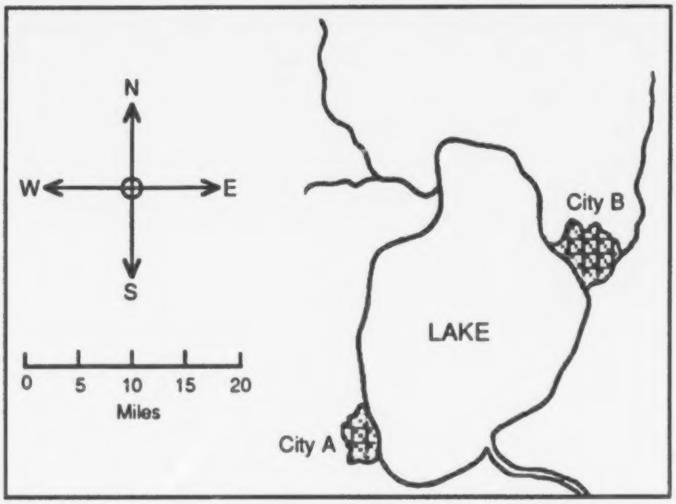
- ☐ $(25.0 \times 101 \times 300)/(202 \times 273)$ L
- ☐ $(25.0 \times 202 \times 273)/(101 \times 300)$ L
- ☐ $(25.0 \times 101 \times 273)/(202 \times 300)$ L
- ☐ $(25.0 \times 202 \times 300)/(101 \times 273)$ L

32. Carbon and silicon are group IV elements and form the oxides CO_2 and SiO_2 respectively. CO_2 is a gas at room temperature and pressure, while SiO_2 melts at about 1700°C. The great difference in melting points is best accounted for by the fact that

- ☐ CO_2 has non-polar molecules, but SiO_2 has polar molecules.
- ☐ $CO_2(s)$ is a molecular solid, but $SiO_2(s)$ is a covalent or network solid.
- ☐ bonds between silicon and oxygen in SiO_2 molecules are many times stronger than bonds between carbon and oxygen in CO_2 molecules.
- ☐ silicon-silicon bonds are stronger than carbon-carbon bonds.

EARTH SCIENCE
EASY
(OPEN-ENDED)

17. The map below represents two cities on the shore of a large lake at 40° north latitude in the middle of a continent.


N
W
E
S
0
5
10
15
20
Miles
City B
LAKE
City A

a. How will the presence of the lake affect the climate of each of the cities at different times of the year? Give reasons for your answers.

11111

b. How will the presence of the lake affect the climate of each of the cities at different times of the day during the summer? Give reasons for your answers.

17. John prepared an aquarium as follows: He carefully cleaned a ten-gallon tank with salt solution and put in a few inches of fine washed sand. He rooted several stalks of weed (*Elodea*) taken from a pool and then filled the aquarium with tap water. After waiting a week he stocked the aquarium with ten one-inch goldfish and three snails. The aquarium was then left in a corner of the room. After a month the water had not become foul and the plants and animals were in good condition. Without moving the aquarium he sealed a glass top on it.

What prediction, if any, can be made concerning the condition of the aquarium after a period of several months? If you believe a definite prediction can be made, make it and then give your reasons. If you are unable to make a prediction for any reason, indicate why you are unable to make a prediction (give your reasons).

17. In the state of Washington, the land to the west of the Cascade mountain range has one of the highest levels of annual rainfall in the United States; yet, the eastern side of the state is so dry that agriculture is possible only with extensive irrigation. How do you explain these facts? Why doesn't the air from the Pacific Ocean, flowing over the Cascade mountains, bring moisture to eastern Washington? Explain this phenomenon as fully as you can. Draw a diagram if it will help your explanation .

17. It is not unusual for geologists to find animal remnants, such as sharks' teeth, embedded in solid rock on a mountainside.

Describe the series of natural events that could result in sharks' teeth being encased in stone far above the surface of the ocean.

17. Explain the steps by which water enters and leaves the atmosphere. Be sure you clearly explain the differences between (a) air, (b) water vapor, (c) clouds, (d) fog, (e) dew, and (f) rain.

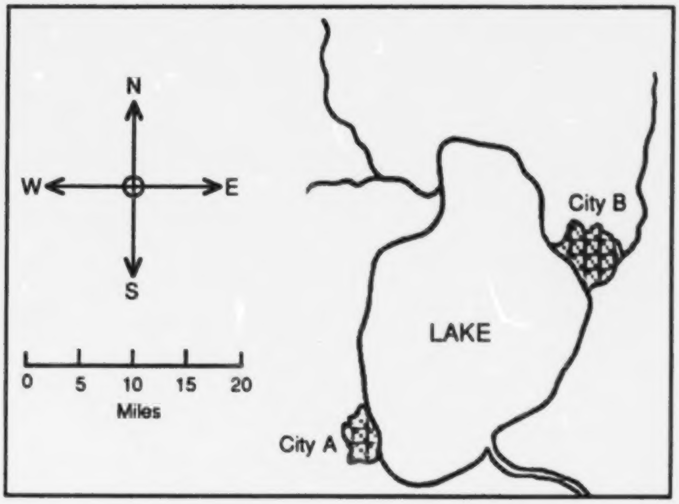
17. In many parts of Europe, ancient buildings made of marble are being damaged by acid rain. Buildings made of granite are not similarly affected.

a. Explain how rain can become acidic, and why the acid attacks marble and not granite.

b. Explain the different geological origins of marble and granite.

EARTH SCIENCE
INTERMEDIATE
(OPEN-ENDED)

17. The map below represents two cities on the shore of a large lake at 40° north latitude in the middle of a continent.


N
W
E
S
0
5
10
15
20
Miles
City B
LAKE
City A

a. How will the presence of the lake affect the climate of each of the cities at different times of the year? Give reasons for your answers.

b. How will the presence of the lake affect the climate of each of the cities at different times of the day during the summer? Give reasons for your answers.

17. Geologists have mapped the southern-most advance of the glacier that covered parts of the United States during the last Ice Age.

a. What is the main geological evidence of the FURTHEST POINTS? Describe as many features as you can.

b. What is the evidence that a region was COMPLETELY COVERED by the glacier? Describe as many features as you can.

17. Suppose a friend returning from Florida gave you a small, live tropical fish that he caught in the ocean. He brought it to you in a liter container of sea water. Since the fish can live only in water of the same salinity as the sea water, you will need a salt-water aquarium to keen the fish alive. How would you go about determining how much salt you would have to add to 5 liters of distilled water to match the salt concentration of the water in the liter container? Explain what equipment you would need and how you would use it to find the amount of salt required. If you can think of more than one method of solving this problem, mention a second method.

a. Method 1

b. Method 2

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17. In the United States, the states bordering the eastern side of the Rocky Mountains have dry climates. In South America, the part of the Amazon Basin bordering the eastern side of the Andes Mountains has an extremely wet and rainy climate.

a. Explain what accounts for the difference in these effects of the Rocky Mountains and the Andes.

b. Explain what kind of climate you would expect in Peru, west of the Andes Mountains.

17. Portland cement is made by heating certain types of limestone in a large rotating drum until the rock turns to powder. Concrete is made by mixing a certain amount of sand and water with cement powder and waiting for the mixture to harden.

a. Explain what causes the solid limestone to change to cement powder and then back to solid concrete.

b. The Romans used cement in making some of their buildings and aqueducts. Since they did not have machinery large enough to make sufficient cement for these purposes, where could they have found it? What geological process could produce natural cement?

17. During most of the year, much of the United States has alternating periods of wet and dry weather. Describe the atmospheric changes involved in one cycle from wet to dry. Be sure to mention how these changes would affect the readings of the following meteorological instruments. You may draw a diagram if you wish.

a. Thermometer

b. Barometer

c. Hygrometer

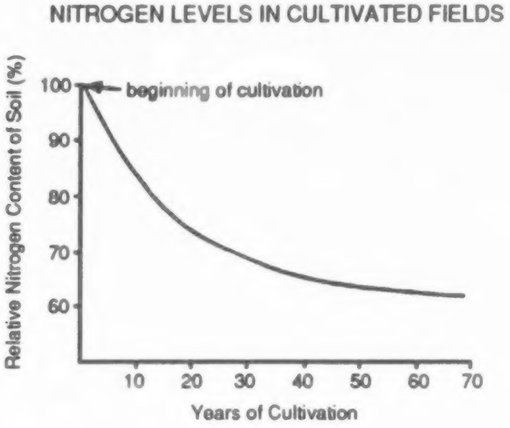
d. Weather vane

e. Anemometer

f. Radiometer

EARTH SCIENCE
DIFFICULT
(OPEN-ENDED)

17. The figure below shows the relationship between cultivation and the nitrogen content of prairie soil.



a. Suggest three possible reasons for the effect shown.

b. What tests or further studies would be necessary to determine the actual cause of the decline?

17. Using the data below:

Distance between the planets and the sun

Planet	Distance	Time
Mercury	0.39	?
Venus	0.72	0.6
Earth	1.0	1.0
Mars	1.5	2.5

Planet	Distance	Time
Jupiter	5.2	11.9
Saturn	?	30.0
Uranus	19	84.0
Neptune	30	165.0

NOTE: the distances are in 'Astronomical Units'.
(The Earth is 1 Astronomical Unit from the sun.)
The times are in Earth years.

a. Plot a graph of Distance (X-axis) against Time to orbit the Sun (Y-axis). You may ignore Neptune in order to get the graph on a reasonable scale.

b. When astronomers tried to find out how long it took Mercury to orbit the Sun, it was too close to the Sun to be clearly detected. Use the graph to work out how long Mercury takes to orbit the Sun.

c. On the the nights the astronomers tried to observe Saturn, it was too cloudy to see anything. Using the data, work out how far Saturn is from the Sun. Show how you came to your decision.

d. During the measuring of Mars' year, there seemed to be some problems with the equipment, but the astronomers are not sure whether this affected the results or not. Do you think that the problems with the equipment affected the results that the astronomers obtained for Mars' year? Explain.

17. A group of astronomers have been gathering information about different stars in our galaxy. Some of their data is shown below.

The Stars In Our Galaxy

No.	Name	Mass compared to Sun	Lifetime (millions of years)	Brightness compared to Sun	Surface temp. (^{0}C)	Color	Final form
1	Zeta Ophiuchi	25	3	80,000	40,000	blue/white	Black hole
2	Spica	16	15	10,000	33,000	blue/white	Neutron star
3	Regulus	6	100	600	17,000	white	Neutron star
4	Sirius A	3	500	60	9200	white	Black dwarf
5	Procyon A	1.7					
6	Altair	1.5	2000	6	6800	yellow/white	Black dwarf
7	Sun	1	10,000	1	5500	yellow	Black dwarf
8	Epsilon Eridani	0.8	20,000	0.4	4200	orange	Black dwarf
9	Proxima Centauri	0.1				orange/red	

Compared to stars, planets are very small, and cold. For example, the sun is about a million times bigger than Earth, and the surface of the Earth is about 20°C whereas the sun's is 5,500°.

Planets also tend to be formed of rock, whereas stars are formed of gas.

The largest planet in our solar system is Jupiter, and there are several unusual things about it: it is made almost entirely of gas, with only a small solid core; and, it is giving out light.

Because of this, one astronomer suggests that Jupiter may be thought of as a very small, dim star! However, the mass of Jupiter is $\frac{1}{1,000}$ (0.001) of mass of the sun.

a. Using the data in the table, estimate how bright is Jupiter compared to the sun.

b. Estimate the surface temperature of Jupiter.

c. What sort of light does Jupiter emit?

d. Explain any factors that are not taken into account.

17. In 1672, a French expedition to South America found that their pendulum clock, which kept highly accurate time in France, lost about $2\frac{1}{2}$ minutes a day near the equator.

a. How would you explain this effect?

b. With what would the explorers compare their clock in South America in order to know it was losing time?

17. A group of astronomers have been gathering information about different stars in our galaxy. Some of their data is shown below.

The Stars In Our Galaxy

No.	Name	Mass compared to Sun	Lifetime (millions of years)	Brightness compared to Sun	Surface temp. (^0C)	Color	Final form
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6	Altair	1.5	2000	6	6800	yellow/white	Black dwarf
7	Sun	1	10,000	1	5500	yellow	Black dwarf
8	Epsilon Eridani	0.8	20,000	0.4	4200	orange	Black dwarf
9	Proxima Centauri	0.1				orange/red	

They have developed a theory that stars change as they 'use up' their energy. When they have used up their energy, they change dramatically and can end up in one of three forms: either as a Black Hole, a Neutron Star, or as a Black Dwarf.

a. According to the theory what sort of stars eventually become Black Holes?

b. What sort of stars eventually become Black Dwarfs?

c. Describe any other patterns or trends that you can see in the data.

17. During most of the year, much of the United States has alternating periods of wet and dry weather. Describe the atmospheric changes involved in one cycle from wet to dry. Be sure to mention how these changes would affect the readings of the following meteorological instruments. You may draw a diagram if you wish.

a. Thermometer

b. Barometer

c. Hygrometer

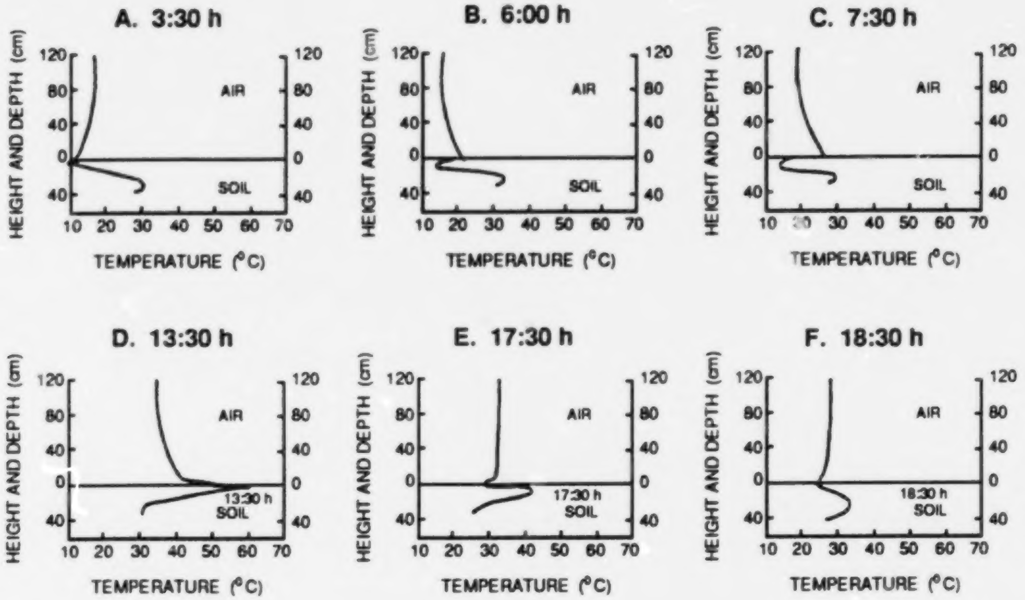
d. Weather vane

e. Anemometer

f. Radiometer

EARTH SCIENCE
MORE DIFFICULT
(OPEN-ENDED)

17. The figures below display graphs of temperatures in a desert region of the south-western United States over a fifteen hour period in summer. The temperatures were measured from the earth's surface to a depth of 40 cm into the soil and to a height of 120 cm into the atmosphere. Account for the shapes of the graphs and their changes in the course of the day. Be sure to mention each of the six graphs.



17. Suppose that the state engineering corps is proposing to build a dam on a small river to provide water for a nearby town.

a. How might they go about estimating the amount of water that could be taken from the dam annually for this purpose? What measurements would they need? What assumptions would they have to make?

b. Assume some plausible values for the measurements and show the calculation of the volume of water that would be available annually.

17. During the recent major earthquake in California, a curious thing happened in a house just west of the epicenter of the quake: when the owners returned home after the quake, they found that in addition to many dishes having fallen to the kitchen floor, a heavy pool table in their family room had changed about three feet southeastward relative to its original position in the room.

a. How do you explain the change in position of the pool table?

b. What type of earthquake is most likely to produce this kind of effect?

c. Why does this type of earthquake occur on the California coast?

17. In 1672, a French expedition to South America found that their pendulum clock, which kept highly accurate time in France, lost about $2\frac{1}{2}$ minutes a day near the equator.

a. How would you explain this effect?

b. With what would the explorers compare their clock in South America in order to know it was losing time?

17. There is considerable geological evidence that at some time in the distant past much more of the Earth's land surface was low, warm, and moist plains than presently exists.

a. Describe the processes that are believed to have shaped the present land masses, now dominated by great mountain ranges and large, dry desert areas.

b. How do these changes in the profiles of the land masses account for the associated changes in the Earth's climate.

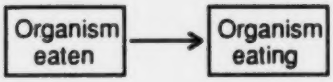
17. Explain the relationship between geology, the study of the formation and composition of surface rocks of the Earth's crust, and paleontology, the study of fossil remains of animals. How does paleontology help establish the chronological sequence of layers of surface rocks? What are the main periods of formation of the Earth's surface identified in this way?

BIOLOGY
EASY
(OPEN-ENDED)

17. The table below shows some of the organisms in a certain habitat and the organisms that feed on them.

Organisms that are eaten	Organisms that eat them
Garden vegetables	Slugs and insects
Slugs and earthworms	Small birds
Organisms in soil	Earthworms
Small birds and frogs	Hawks and falcons
Insects	Frogs and small birds

a. Draw a food-chain diagram including all the organisms listed above. Use the symbols



to represent links in the chain.

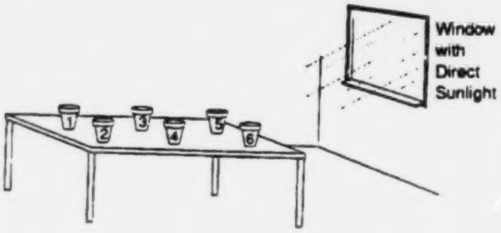
b. When the chemical insecticide DDT was introduced into agriculture, peregrine falcons were almost wiped out because DDT made the shells of their eggs extremely fragile. Refer to your food-chain diagram to explain how DDT might get into the falcon's eggs.

17. A student wanted to find out in which of three conditions tomatoes would ripen most quickly: on the plant or when removed and enclosed in a plastic bag or a brown paper bag.

a. How would you set up the experiment?

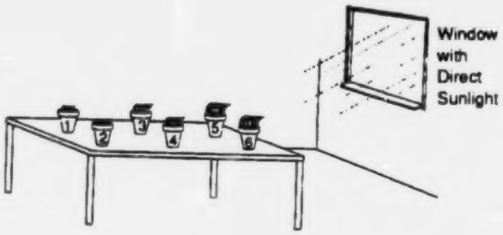
b. What problems might you have in trying to make it a fair test?

18. Figures 1 and 2 below show an experiment that was conducted by a student in a biology class. Grass seed was planted in 6 small flower pots of the same size using the same type of soil in each pot. The pots were placed on a table along the back wall of the classroom and watered as follows:



At Beginning of Experiment

Figure 1



After 1 Month

Figure 2

Pots 1 and 2—provided with 100 mL H_2O each day

Pots 3 and 4—provided with 100 mL H_2O every other day

Pots 5 and 6—provided with 100 mL H_2O once each week

The student measured the height of the grass in the pots one month after planting. The results of the experiment are shown in Figure 2.

a. What variables did the student intend to examine in the experiment?

b. Describe ways that the student could improve the design of the experiment so that it would be more valid.

c. What conclusions can you make from the results of the experiment? Explain.

17. The Cell Theory includes the Theory of Biogenesis. This states that "All living things come from pre-existing cells."

a. How does this theory describe where microorganisms, such as bacteria, come from?

b. How does this explain your own existence and coming into this world?

c. How can a single cell form a tissue or organ in a multicellular organism?

d. All parts of the cell are somewhat involved in cell reproduction. What parts of the cell are most likely to be involved in making more cells?

17. Diagram 1 shows how the amount of light and the amount of carbon dioxide change with depth in a lake. The wider the column, the greater the amount.

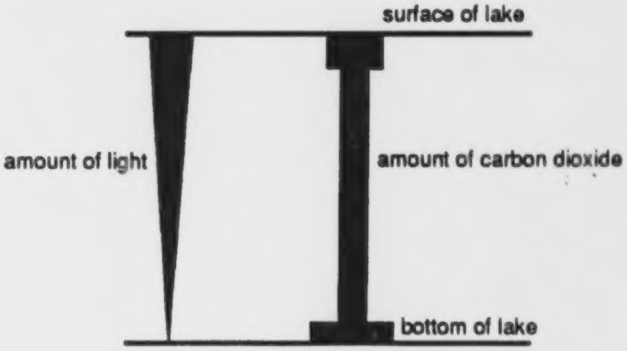

surface of lake
amount of light
amount of carbon dioxide
bottom of lake

Diagram 1

Certain plants grow in the lake and like all plants they need to photosynthesize.

Things needed for photosynthesis	Things produced by photosynthesis
carbon dioxide water light	oxygen carbohydrate

Use the information above to decide where the plants are most likely to grow in the lake. Diagram 2 shows the lake.

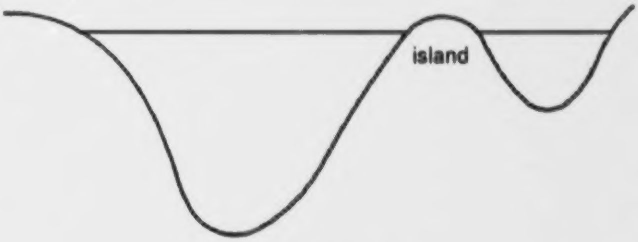
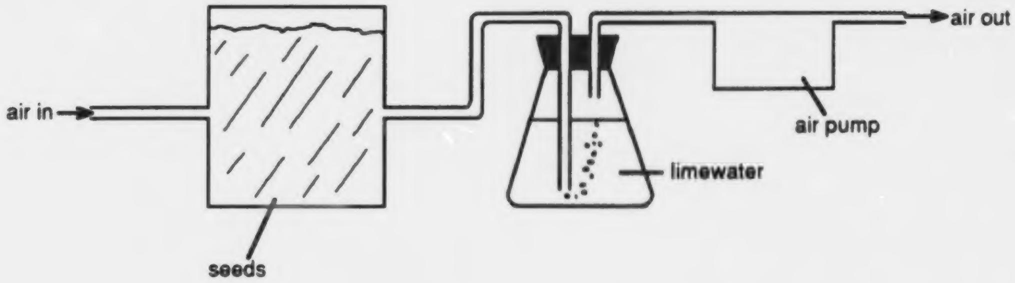


Diagram 2

a. Mark with a 'P' on Diagram 2 all the places where water plants might grow.

b. Explain how you decided where plants will grow.

17. Suppose air is drawn through a large container of sunflower seeds and into limewater as shown in the diagram below.


air in
seeds
limewater
air pump
air out

a. What change should gradually occur in the appearance of the limewater?

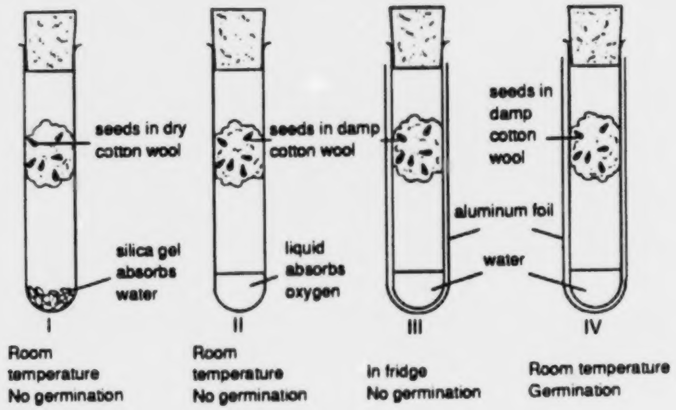
b. What does the changing of the limewater prove about the sunflower seeds?

c. If the appearance of the limewater does not change, what do you conclude about the seeds?

d. What experiment could you perform to test your conclusion in Item c?

BIOLOGY
INTERMEDIATE
(OPEN-ENDED)

17. The following experiment was set up and the results recorded.


seeds in dry cotton wool
silica gel absorbs water
seeds in damp cotton wool
liquid absorbs oxygen
seeds in damp cotton wool
aluminum foil
water
I
II
III
IV
Room temperature No germination
Room temperature No germination
In fridge No germination
Room temperature Germination

a. What conclusion can be drawn by comparing test-tubes I and IV?

b. What conclusion can be drawn by comparing test-tubes II and IV?

c. What conclusion can be drawn by comparing test-tubes III and IV?

d. Why is it necessary to set up test-tube IV? Explain your answer.

e. What other experiments should be done before we can be sure of the conditions necessary for germination?

17. The Cell Theory states that all living things are made of cells. However, cells come in many shapes and sizes. Many cells have a nucleus but some do not, and some others even have two or more nuclei. It is relatively easy to remove a nucleus from a cell by viewing it through a microscope, and then removing it with a very small needle attached to the end of a device called a micromanipulator (which lets you move the needle a very small distance). If you were given cells that normally contain a nucleus, answer the following:

a. Write an hypothesis about the importance of the nucleus for these cells.

b. Design a simple experiment to test your hypothesis.

c. What do you think is the job of the cell's nucleus?

d. What other kinds of observations with the microscope would show you what the nucleus does?

e. The mature red blood cell of a frog has a nucleus but not that of a human. Both carry on the same function, carrying oxygen to the cells. What explanation can you give for this difference in the red blood cells of these two species?

18. Blood transfusions during operations were not generally successful until it was found that the blood type of the donor must be compatible with that of the recipient.

a. What are blood types and how are they determined?

b. What are the compatible blood types of donor and recipient in the ABO system?

c. How are ABO blood types inherited?

18. In the early 1900's an experiment was carried out on rats and their diet. Rats from the same litter and of the same average weight were randomly divided into two groups, and fed as follows.

	Days 0-17	*Days 18-50*
Group A	Purified protein, glucose, starch, fat minerals and water only.	As before, plus 3 cm milk per day.
Group B	As for group A, plus 3 cm milk per day.	Purified protein, glucose, starch, fat, minerals and water only.

The results are given below:

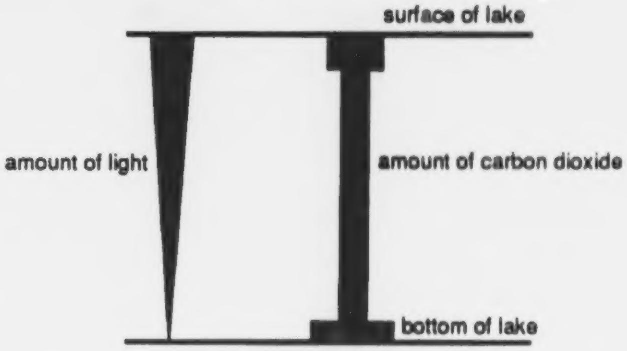
	Average mass (g)											
	Days	0	5	10	15	20	25	30	35	40	45	50
Group A		45	48	52	50	46	50	60	65	70	75	82
Group B		45	55	64	73	80	85	86	87	87	82	75

a. Prepare a graph which shows how the average masses of groups A and B varied. Add two arrows at day 18 to show how where their diets were changed over.

b. Describe by reference to the graph the changes in average weight that occur in group A and B rats before and after day 18.

c. What conclusions can be drawn from this experiment, and why is it important for human beings?

17. Diagram 1 shows how the amount of light and the amount of carbon dioxide change with depth in a lake. The wider the column, the greater the amount.


surface of lake
amount of light
amount of carbon dioxide
bottom of lake

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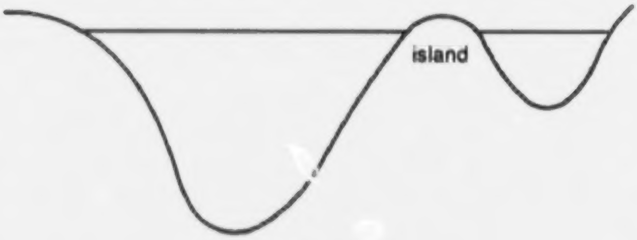

Diagram 2

a. Mark with a 'P' on Diagram 2 all the places where water plants might grow.

b. Explain how you decided where plants will grow.

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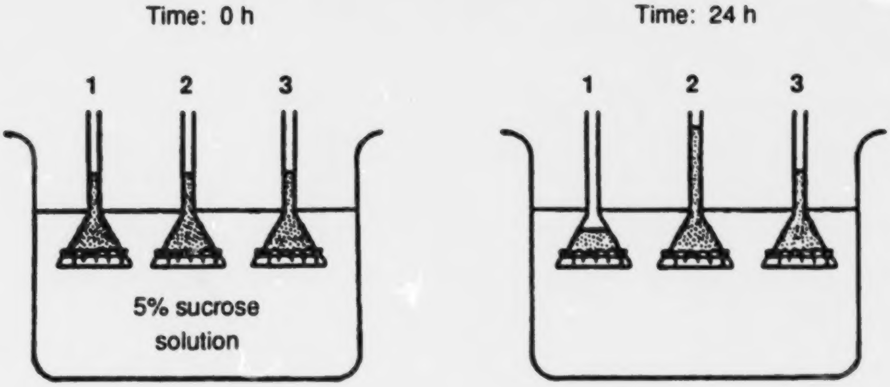
17. Some human traits (for example, color-blindness) are said to be inherited in a sex-linked manner.

a. What chromosomal mechanism accounts for sex-linked inheritance?

b. Why do men more often express sex-linked recessive traits than do women?

BIOLOGY
DIFFICULT
(OPEN-ENDED)

17. Dialysis tubing, which is impermeable to sucrose, was securely tied over the wide end of each of three funnels, numbered 1, 2, and 3. An equal volume of sucrose solution of different concentrations was placed in each of the funnels. The three funnels and their contents were then placed in a 5% sucrose solution. After 24 hours, the level of the solution in each funnel was noted.



On the basis of the results illustrated, estimate the concentration of the solutions initially placed into each of the funnels. Give reasons for each of your answers. State the principles involved.

a. Funnel 1

13211

b. Funnel 2

c. Funnel 3

17. The following data were obtained in a fifty year study of a woodlot. They show the population density of two tree species, the sugar maple, (*Acer saccharum*), and the hemlock (*Tsuga canadensis*).

YEAR	1930	1935	1940	1945	1950	1955
A. saccharum	35.0	35.8	36.0	37.4	37.2	37.4
T. canadensis	2.5	4.2	6.3	6.9	7.2	8.8

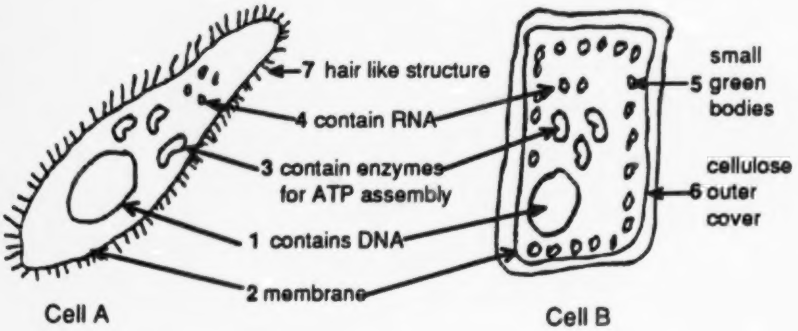
YEAR	1960	1965	1970	1975	1980
A. saccharum	36.1	34.3	33.1	32.3	30.2
T. canadensis	9.6	10.1	11.9	12.1	12.6

a. Make a graph to represent the data.

b. Interpret the results, giving two possible hypotheses to account for the trends observed.

c. Predict the outcome over the next fifty years.

17. The following diagrams of two different cells were drawn by a biologist after looking at these cells through a microscope. Study them carefully.


7 hair like structure
4 contain RNA
3 contain enzymes for ATP assembly
1 contains DNA
2 membrane
small
5 green
bodies
cellulose
6 outer
cover
Cell A
Cell B

a. Would these two cells likely be found in the same organism? Explain your answer.

b. Is Cell A likely to be animal or plant?

c. Is Cell B likely to be animal or plant?

d. What part(s) tell you if it is an animal cell or a plant cell? Give your reasons.

e. Which cell is most likely to move about on its own? Which part(s) of the cell give you a clue to its ability? Name the part(s) by name and number.

f. Which cell(s) is(are) likely to be autotrophic (make its(their) own food)?

g. What cell parts are needed to be autotrophic? Give the part number(s) and the correct biological name(s).

18. In the early 1900's an experiment was carried out on rats and their diet. Rats from the same litter and of the same average weight were randomly divided into two groups, and fed as follows.

	Days 0-17	*Days 18-50*
Group A	Purified protein, glucose, starch, fat minerals and water only.	As before, plus 3 cm milk per day.
Group B	As for group A, plus 3 cm milk per day.	Purified protein, glucose, starch, fat, minerals and water only.

The results are given below:

	Average mass (g)											
	Days	0	5	10	15	20	25	30	35	40	45	50
Group A		45	48	52	50	46	50	60	65	70	75	82
Group B		45	55	64	73	80	85	86	87	87	82	75

a. Prepare a graph which shows how the average masses of groups A and B varied. Add two arrows at day 18 to show how where their diets were changed over.

b. Describe by reference to the graph the changes in average weight that occur in group A and B rats before and after day 18.

c. What conclusions can be drawn from this experiment, and why is it important for human beings?

17. Two main orders of mammals are the marsupials (for example, the kangaroo) and the placental mammals (most other common mammals).

a. Describe and compare the main stages of development of the young of these two types of mammals from conception to one year of age.

b. Why are marsupials the only mammals native to Australia?

17. Bacteria and viruses both cause disease, but they do so in entirely different ways.

a. Describe and compare the ways that bacteria and viruses reproduce in the human body.

b. What are the main differences in the medical treatment of bacterial and viral diseases?

BIOLOGY
MORE DIFFICULT
(OPEN-ENDED)

17. A student investigated the action of saliva on a suspension of starch and on a suspension of cellulose by setting up the following test tubes:

1. 2 mL of starch suspension

2. 2 mL of cellulose suspension

3. 2 mL of saliva

4. 2 mL of starch suspension + 2 mL of saliva

5. 2 mL of cellulose suspension + 2 mL of saliva

The pH of each test tube was 7.5. The test tubes were maintained in a water bath at 37°C for 10 min. A benedict's test was then carried out on the contents of each test tube. The following observations were recorded:

1. blue (no change)

2. blue (no change)

3. blue (no change)

4. brick red

5. blue (no change)

a. Interpret the observation

b. Why were test tubes 1, 2, and 3 set up? What did they show?

c. Explain the result in test tube 4.

17. The following data were obtained in a fifty year study of a woodlot. They show the population density of two tree species, the sugar maple, (*Acer saccharum*), and the hemlock (*Tsuga canadensis*).

YEAR	1930	1935	1940	1945	1950	1955
A. saccharum	35.0	35.8	36.0	37.4	37.2	37.4
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YEAR	1960	1965	1970	1975	1980
A. saccharum	36.1	34.3	33.1	32.3	30.2
T. canadensis	9.6	10.1	11.9	12.1	12.6

a. Make a graph to represent the data.

b. Interpret the results, giving two possible hypotheses to account for the trends observed.

c. Predict the outcome over the next fifty years.

18. Ten milliliters of a cloudy egg-white suspension were added to each of five test tubes labeled A, B, C, D, and E. The following additions were made to the test tubes:

Tube A: 1 mL of pepsinogen solution

Tube B: 1 mL of distilled water and 5 drops of dilute HCL

Tube C: 1 mL of pepsinogen solution and 5 drops of dilute HCL

Tube D: 1 mL of pepsinogen solution that had been previously boiled and then cooled, and 5 drops of dilute HCL

Tube E: 1 mL of distilled water

The test tubes and their contents were placed in a water bath at 37°C. After sufficient incubation time, the tubes were withdrawn from the water bath and examined for differences in the cloudiness of the suspension. Note: Digested protein solution is clear, undigested protein suspension is cloudy.

Predict the appearance of the contents of each test tube and explain why digestion has or has not occurred. (Use complete sentences to present your answers.)

a. Tube A:

b. Tube B:

c. Tube C:

d. Tube D:

e. Tube E:

18. A pure-breeding red-flowered plant was crossed with a pure-breeding white-flowered plant: RR × rr.

a. What percentage of the gametes made by the red-flowered plant will carry a red allele?

b. What percentage of the gametes made by the white-flowered plant will carry a white allele?

c. What will be the genotype of the offspring?

d. If R is dominant to r, what will be the color of the offspring?

A red-flowered plant (Rr) was crossed with a similar red-flowered plant (Rr × Rr).

e. What percentage of the gametes produced by these plants will carry a red allele?

f. What percentage of the gametes produced by these plants will carry a white allele?

g. What percentage of the offspring will be red?

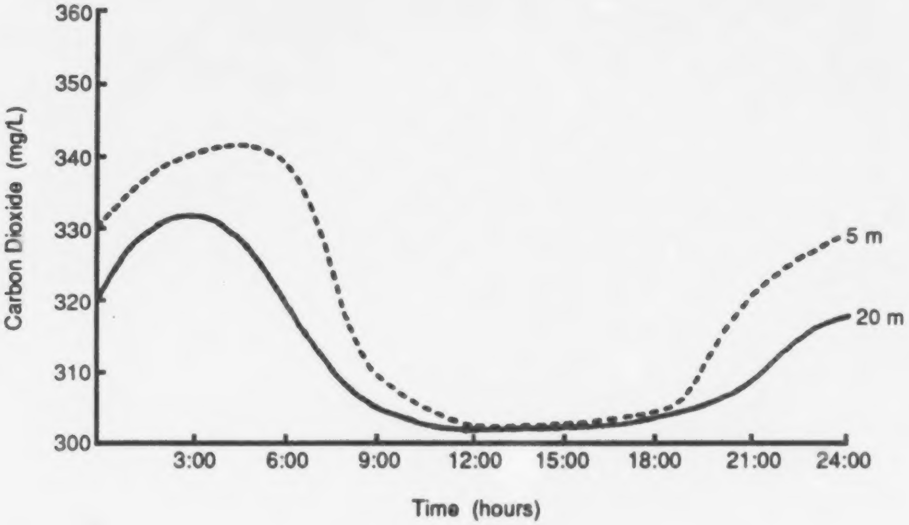
h. What percentage of the offspring will be white?

17. A cell membrane must have the properties to exist in a liquid environment without dissolving. In addition, it must keep many things inside or outside the cell, as well as allowing other material to pass through the membrane.

Describe the modern concept of the cell membrane so that it can handle the above stated problems. You may include a labeled drawing.

17. The figure below shows daily fluctuations in the content of carbon dioxide in a forest canopy at different levels in the canopy.

CARBON DIOXIDE CONTENT OF THE ATMOSPHERE
IN A FOREST CANOPY AT DIFFERENT HEIGHTS



a. Explain the possible cause(s) for the difference in the data obtained at the two heights.

b. What do you expect the curve of the temperature taken at ground level to look like? Support your answer.

64212

CHEMISTRY
EASY
(OPEN-ENDED)

17. When starting a wood fire in a fire place, you light paper, wood shavings, and small kindling first. The logs and larger pieces of wood catch fire later.

a. Why can paper and wood shavings be easily lit with a match, but larger kindling and logs cannot?

b. Why do small pieces of wood burn more rapidly than larger pieces?

c. How do you decide on how large your pieces of firewood should be?

17. The two main methods of cleaning clothes are dry cleaning and wet wash. Dry cleaning makes use of solvents manufactured from petroleum; wet wash uses water, detergents, and bleach.

a. Explain how each of these cleaning methods removes dirt and stains from clothes.

b. Explain why both detergents and bleach are often used in wet wash.

c. Explain why dry cleaning is better for some types of dirt on clothes and wet wash is better for other types of dirt on clothes.

17. When gasoline burns in the cylinder of an automobile engine, a certain amount of poisonous carbon monoxide is formed. For this reason it is dangerous to work in a garage with the doors closed when an automobile engine is running. But when kerosene is burned in a space heater, practically no carbon monoxide is formed. So it is generally safe in winter to work in a garage warmed by a kerosene space heater even when the doors are closed.

a. What is the difference between these two types of combustion?

b. Kerosene can be used as a fuel for diesel engines. Would it then burn without producing carbon monoxide? Explain your answer.

17. Jewelers sometimes use a "touchstone" (a form of black quartz with a slightly abrasive surface) to identify various metals. The jeweler rubs the article in question on the stone to obtain a streak of the metal, then examines the color of the streak and applies a little nitric acid to see if it will dissolve. The results for some known metals are as follows:

Metal	Color	Dissolves in nitric acid
Platinum	White	No
Gold	Yellow	No
Silver	White	Yes
Brass	Yellow	Yes
Pewter	White	Yes

a. Which two of these metals cannot be distinguished by the touchstone results?

b. Suggest a way of distinguishing between a platinum article and a silver article without removing any metal.

17. Hydrogen and helium are both lighter than air and can be used in balloons, blimps, and dirigibles. But hydrogen easily burns or explodes and is now considered too dangerous to use for lighter-than-air craft. All modern balloons and blimps use helium, which does not burn.

a. Explain why these two gases are different in their ability to burn.

b. What reaction can be used to make hydrogen?

18. Dust in the air in flour mills or grain silos has been known to explode violently when ignited by a spark or flame.

a. Explain why flour or dust from grain can explode when suspended in air, but burns quietly when it is in a pile on the ground.

b. Cement is also kept in large silos and is dust, but it does not explode in the presence of sparks or flame. Explain why not.

CHEMISTRY
INTERMEDIATE
(OPEN-ENDED)

17. In a container of fixed volume and at constant temperature, one mole of O_2 exerts a pressure of 1,520mm. If a second mole of O_2 is pumped into the container, the pressure is increased to 3,040mm. Addition of a third mole raises the pressure to 4,560mm, and a fourth mole raises it to 6,080mm.

a. Plot the pressure (y-axis) vs. the number of moles (x-axis).

b. Describe in words the relationship between the pressure and the number of moles of gas.

c. What pressures would you observe if N_2 were substituted for O_2 in this experiment?

d. Explain how the theory of ideal gases accounts for the results of the two experiments.

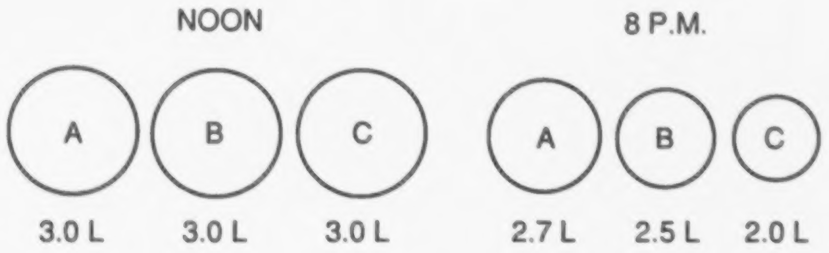
17. The two main methods of cleaning clothes are dry cleaning and wet wash. Dry cleaning makes use of solvents manufactured from petroleum; wet wash uses water, detergents, and bleach.

a. Explain how each of these cleaning methods removes dirt and stains from clothes.

b. Explain why both detergents and bleach are often used in wet wash.

c. Explain why dry cleaning is better for some types of dirt on clothes and wet wash is better for other types of dirt on clothes.

17. As you come into the classroom, there are three inflated balloons, all of the same volume, tied to a desk. After 8 hours all the balloons have reduced volumes, according to the diagram below. Propose two different hypotheses that could explain both: (a.) the reduction in volumes and (b.) the unequal reduction in volumes. Describe tests to check your hypotheses.



a. Hypothesis A: The reduction in volumes.

b. Hypothesis B: The unequal reduction in volumes.

17. Gelatin for use in food products is made by soaking animal bones in an acid such as acetic acid. The bone then becomes soft and transparent and is dissolved in hot water. Later, as the water cools gelatin is formed.

Explain the reactions that take place in making gelatin.

a. What substance is dissolved from the bone by the acid?

b. What happens to the acid in the reaction?

c. What happens to the water when the hot gelatin solution cools and solidifies?

18. Because iron pyrite, FeS_2, occurs naturally in the form of bright, gold colored crystals, it has been called "fools gold".

a. Suggest some tests you could perform to distinguish between flakes of iron pyrite and flakes of gold.

b. Iron pyrite is frequently found in veins of coal. Why is it dangerous for coal miners if iron pyrite comes into contact with acids? Show the reaction.

18. A weak solution of ammonia, NH_3, in water is often used as a cleaning agent. So is a solution of sodium carbonate, Na_2CO_3.

Write the reactions of ammonia with water and sodium carbonate with water, and explain why these solutions are useful as cleaning agents.

CHEMISTRY
DIFFICULT
(OPEN-ENDED)

17. Aluminum oxide (Al_2O_3) is $1\frac{1}{2}$ times more abundant on the earth's surface than iron oxide (FeO). In spite of this, iron was known and produced over 2,000 years ago, whereas aluminum was only discovered in the 19th century and only produced in quantity in the first part of the 20th century.

What reasons can you suggest for the different histories of these two very useful metals?

17. A series of chemical reactions will convert 2.24 g of iron fillings into 3.20 g of a red oxide of iron. The relative atomic masses of oxygen and iron are 16 and 56 respectively.

There are four stages in this series of reactions:

1. addition of dilute sulphuric acid
2. addition of hydrogen peroxide solution
3. addition of aqueous sodium hydroxide
4. dehydration by heating the precipitate

a. What is the mass of oxygen added to the iron in the series of reactions? Show your calculations.

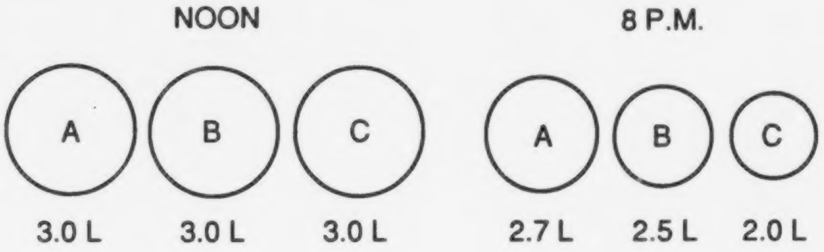
b. Calculate the amount (in moles) of oxygen atoms in this mass. Show each step.

c. Calculate the amount (in moles) of iron atoms which were present at the start. Show each step.

d. What is the ratio of the amounts of iron to oxygen? Show the calculation.

e. What is the empirical formula of the red oxide?

17. As you come into the classroom, there are three inflated balloons, all of the same volume, tied to a desk. After 8 hours all the balloons have reduced volumes, according to the diagram below. Propose two different hypotheses that could explain both: (a.) the reduction in volumes and (b.) the unequal reduction in volumes. Describe tests to check your hypotheses.



a. Hypothesis A: The reduction in volumes.

33311

b. Hypothesis B: The unequal reduction in volumes.

33312

17. How does the atomic structure of metals account for their typical properties, electrical conductivity, malleability, and ductility, luster, etc.?

18. Titanium tetrachloride, $TiCl_4$, is used to produce smoke for special effects in movie making.

a. Show the reaction that accounts for this liquid-producing dense white smoke when released in air.

b. How is this reaction related to the fact that titanium has now replaced lead as a source of white pigments for paints? Why is titanium preferred over lead?

18. When metallic copper, Cu, is placed in a solution of silver nitrate, $AgNO_3$, the solution slowly becomes pale blue and fine crystals of metallic silver appear on the copper.

a. Write the chemical equation that accounts for these effects.

b. Show the gains and losses of electrons between the copper and the silver in the reaction.

CHEMISTRY
MORE DIFFICULT
(OPEN-ENDED)

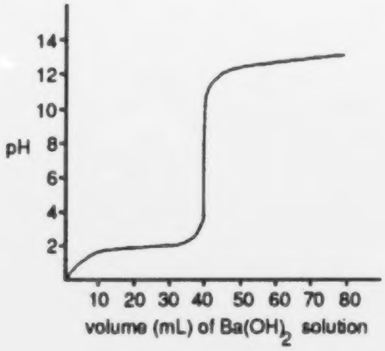
17. A potassium permanganate ($KMnO_4$) solution is purple even when very dilute. The Mn^{2+} (aq) ion is practically colorless. Solutions of tin salts are also colorless. $KMnO_4$ can be used to assay solutions of $SnCl_2$ (aq) by titrating to the first appearance of permanent purple color.

Suppose 100 ml of $SnCl_2$ (aq) is titrated with a 0.1 molar (0.1 mol/liter) solution of $KMnO_4$. If the end point is reached at 24 ml of $KMnO_4$, what is the concentration of Sn^{2+}, in moles per liter, in the assay sample?

a. As the first step in solving this problem, write the balanced net ionic equation.

b. Show your calculation of the Sn^{2+} (aq) concentration.

17. A 20.0 mL sample of 0.020 mol/L HCl solution was titrated with a 0.010 mol/L $Ba(OH)_2$ solution. The graph below resulted from the collected data.



Identify two features of the graph that do not agree with the information in the description of that titration. Describe how the graph should look for each of these features and provide a supporting calculation for each correction identified.

a. Feature 1.

b. Feature 2.

17. Consider:

$2Al(s) + \frac{3}{2}O_2(g) \rightarrow Al_2O_3(s)$; $\Delta H = -400$ Kcal/mole Al_2O_3, and

$2Fe(s) + \frac{3}{2}O_2(g) \rightarrow Fe_2O_3(s)$; $\Delta H = -200$ Kcal/mole Fe_2O_3.

a. Calculate the heat liberated when 1 mole of Fe_2O_3 reacts with Al.

b. Write the equation of the reaction.

c. What practical application can be made of this reaction?

17. A lab technician prepared several 0.10 mol/L solutions and forgot to label them. In an attempt to identify the solutions, their pH was measured and recorded as follows.

Solution	pH	Possible Solutions
I	11.6	NaCl(aq); $C_6H_5COOH(aq)$
II	2.6	$Na_2CO_3(aq)$; $HNO_3(aq)$
III	13.0	LiOH(aq); $Ba(OH)_2(aq)$
IV	7.0	
V	1.0	
VI	13.3	

a. Identify each solution:

I ______________________
II ______________________
III ______________________
IV ______________________
V ______________________
VI ______________________

b. Give your reason for each choice based on the data provided.

I

II

III

IV

V

VI

18. It has been said that the difference between ionic bonding and covalent bonding is more a matter of degree than of an absolute distinction.

a. Describe the types of bonds that are intermediate between ionic and covalent.

b. Give examples of the various types of atomic bonding.

18. When metallic copper, Cu, is placed in a solution of silver nitrate, $AgNO_3$, the solution slowly becomes pale blue and fine crystals of metallic silver appear on the copper.

a. Write the chemical equation that accounts for these effects.

b. Show the gains and losses of electrons between the copper and the silver in the reaction.

PHYSICS
EASY
(OPEN-ENDED)

18. Scientists noticed that if a real and an artificial flower are put together in sunlight, bees go to the real one only. If this is done indoors under an ordinary electric lamp, bees do not go to either of the flowers. The scientists took some black and white photographs to try to solve the problem. They used a special film.

DIAGRAM 1
WAVELENGTHS

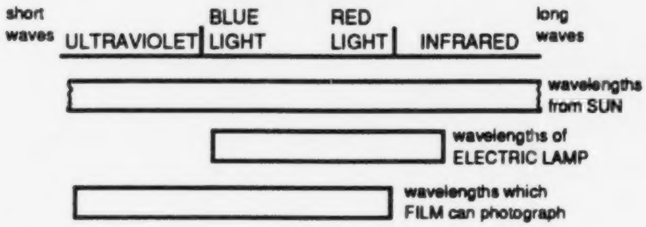
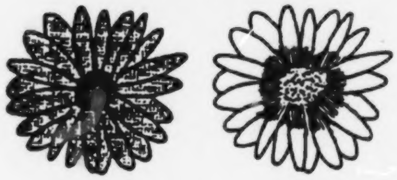

short waves
ULTRAVIOLET
BLUE LIGHT
RED LIGHT
INFRARED
long waves
wavelengths from SUN
wavelengths of ELECTRIC LAMP
wavelengths which FILM can photograph

DIAGRAM 2
PHOTOGRAPHS



A
Electric light

B
Sunlight

Diagram 1 tells us about the wavelengths in sunlight and electric light. It also shows which wavelengths could be photographed by the film. Diagram 2(A) shows a photograph of a coreopsis flower taken in electric light. Diagram 2(B) shows a photograph of the same flower taken in sunlight.

Use this information to work out how bees are attracted to flowers. Explain all your reasoning.

18. Find the power and horsepower of an electric mixer that does 21,600 Newton-meters of work in 3 minutes. (Power equals work divided by time).

17. Compare the physical principles involved in the action of a rocket engine used to place a satellite in orbit and a jet engine of an airplane.

a. What is the source of the force exerted by each engine?

b. In what ways are these two types of engines similar?

c. In what ways are these two types of engines different?

17. A law of static electricity is that objects with an opposite charge of electrons attract one another.

a. Explain how this accounts for the fact that a party balloon, if rubbed against a wool sweater, will stick to a wall or ceiling.

b. How does the balloon get its charge?

c. How does the wall get an opposite charge?

d. What determines how long the balloon will stick to the wall or ceiling?

17. It is well-known that light waves and radio waves are similar phenomena, and that both are part of the electromagnetic spectrum.

a. Then explain why light waves are blocked by objects between the source and the observer, but radio waves are usually not? Draw diagrams if you wish.

b. Does the same principle apply to sound waves? When will sound waves tend to be blocked by interposed objects, and when will they tend not to be blocked? Draw diagrams if you wish.

17. Suppose on a camping trip you are filling an air mattress with a small hand pump.

a. Explain why, if a heavy person is lying on the mattress at the time, you are able to lift him, as the mattress inflates, using very little extra force on the hand pump?

b. Suppose the cross-sectional area of the hand pump is 27 square centimeters and the person on the mattress occupies 5,400 square centimeters of its surface. If the person weighs 90 Newtons, how many extra Newtons of force on the pump would be required to lift him? Show your calculations.

PHYSICS
INTERMEDIATE
(OPEN-ENDED)

18. An object 2.0 cm high is located 12 cm from a converging (concave) mirror of focal length 4.0 cm.

a. Make an accurate, labeled diagram showing the mirror, the focal point F, and the location, orientation and size of the object.

---

b. Use rays to locate the image.

c. Show two different ways the image can be viewed in a reflecting telescope. (Draw diagrams. Label all relevant parts.)

18. A crate weighing 4,200 N is resting on the shop floor. The coefficient of friction between the crate and the floor is 0.200. A man can exert a maximum horizontal force of 850 N.

Can the man shove the crate? Show all calculations.

17. Compare the physical principles involved in the action of a rocket engine used to place a satellite in orbit and a jet engine of an airplane.

a. What is the source of the force exerted by each engine?

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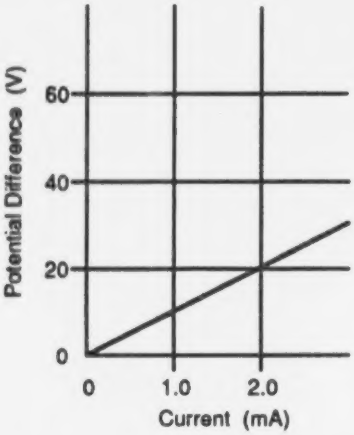
b. In what ways are these two types of engines similar?

c. In what ways are these two types of engines different?

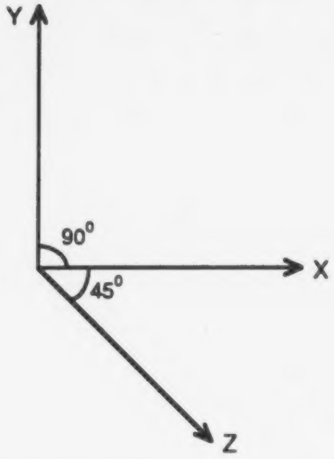
32412

17. The graph of potential difference versus current for a resistor is shown below.



Calculate the resistance of the resistor in ohms. Give the formula and explain each step.

17. As shown below, three forces represented by the vectors X, Y, and Z (in the plane of the page), act against point O with magnitudes of 20 N, 20 N, and $20\sqrt{2}$ N, respectively.



a. Show the steps in constructing the vector of the resultant forces.

b. What is the magnitude of the resultant force, and what is its direction in relation to force X?

17. Four important phenomena of waves transmitting energy in a medium are *reflection, refraction, interference,* and *polarization.*

a. Can all four of these phenomena be observed both in sound and in light? If not, which of these cannot be observed in which medium?

b. Explain your answer to Item a. If possible, give an example of each phenomenon in each medium.

PHYSICS
DIFFICULT
(OPEN-ENDED)

18. An object 2.0 cm high is located 12 cm from a converging (concave) mirror of focal length 4.0 cm.

a. Make an accurate, labeled diagram showing the mirror, the focal point F, and the location, orientation and size of the object.

b. Use rays to locate the image.

c. Show two different ways the image can be viewed in a reflecting telescope. (Draw diagrams. Label all relevant parts.)

18. A student measured the voltage across a constant resistance while varying the current. The results below were obtained.

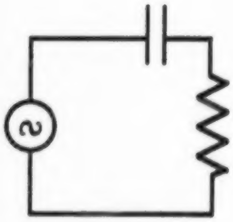
Current (A)	Voltage (V)
0.00	0.0
0.40	1.5
0.90	4.6
1.3	6.0
1.7	9.0
2.4	11.9

a. Make a graph using the above data table. Label the axes appropriately with the independent (manipulated) variable on the horizontal axis.

b. Using the graph, and not the data table above, calculate the resistance (show your work).

c. As an alternate method, use the data table above to find a best estimate for the average resistance (show your work).

17. In an alternating current (AC) circuit with a capacitor and resistor in series (see below),



a. explain the phase relationships of voltage across the capacitor and across the resistor, and

b. explain the phase relationships of current through the capacitor and the resistor.

17. A wire carrying an electric current produces a magnetic field about it. The strength of the field is proportional to the amount of current.

Under what condition will the magnetic fields of two parallel wires carrying current cause the wires to

a. attract each other, or

b. repel each other?

An *ampere* of current is defined as the current that will cause 2×10^{-7} N of force between two parallel conductors set one meter apart from each other.

c. If the current in two such conductors is increased until the force between them is 10^{-6} N, then what is the amperage?

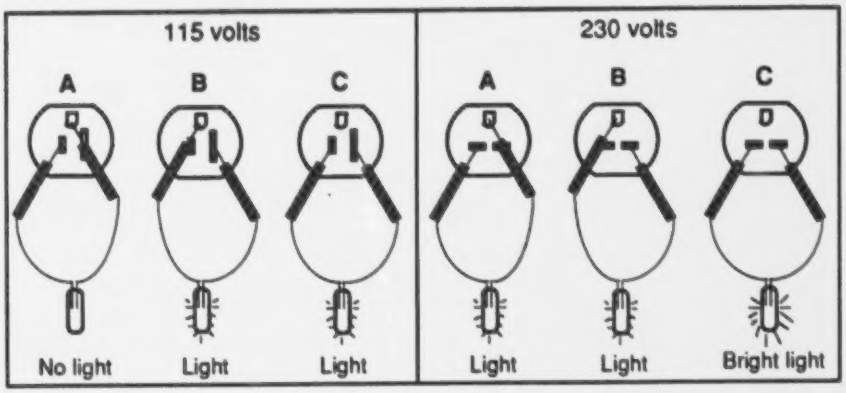
17. The amount of energy required to enable an object to escape into space from the surface of a planet is called its *binding energy*. The formula for the binding energy is GMm/r, where G is the Universal Gravitational Constant, M is the mass of the planet, m is the mass of the object, and r is the distance from the center of the planet.

The *escape velocity* of an object is the velocity, $v_{\rightarrow e}$, at which the object's kinetic energy, given by $\frac{1}{2}mv^2_{\rightarrow e}$, is equal to the binding energy.

a. Find the formula for escape velocity.

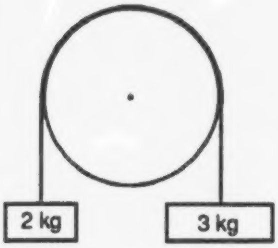
b. Predict how the mass of the planet, the mass of the object, and the altitude of the object will affect its escape velocity.

17. The following diagrams show the effects of probing the contacts of a 115 volt electrical outlet and a 230 volt outlet with a neon test light. In each case the top contact is the ground connection. Explain the results.


115 volts
A
B
C
No light
Light
Light
230 volts
A
B
C
Light
Light
Bright light

PHYSICS
MORE DIFFICULT
(OPEN-ENDED)

18. Two masses, of 2.0 and 3.0 kg respectively, are connected by a light string which passes over a smooth pulley. Air resistance is to be neglected.

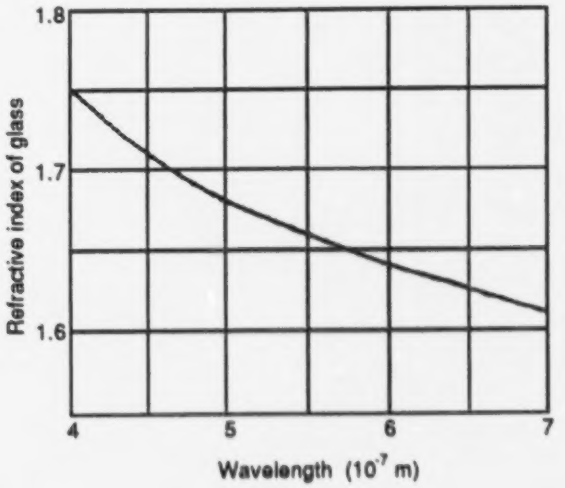


a. What is the magnitude of the acceleration of the 2kg mass? Explain the reasoning behind your answer.

b. What is the tension in the right-hand section of the string? Explain how you arrived at your answer.

14412

18. Below is a graph of the refractive index for a particular glass as a function of the wavelength of the incident light.

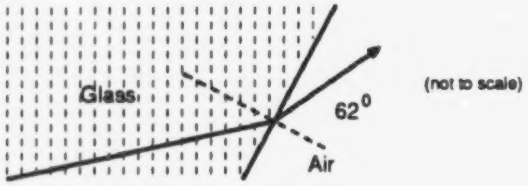


A parallel beam of light contains two wavelengths of light, violet ($\lambda_v = 4.00 \times 10^{-7}$ m) and red ($\lambda_r = 6.50 \times 10^{-7}$ m). The beam travels from air to glass and strikes a piece of glass at an incident angle of 80.0°.

a. Sketch a diagram of the incident and the refracted beams, indicating the angles of incidence and refraction. Label the red and the violet beams within the glass.

b. Calculate the angle between the red and the violet beams inside the glass.

17. A beam of light is incident upon an air-glass boundary, and the angle of refraction is 62°. The relative refractive index of glass to air is 1.47.

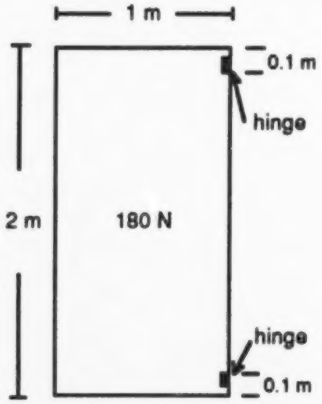


a. What is the angle of incidence for the beam traveling from glass to air? (Answer to the nearest degree.) Explain your calculations.

34411

b. What is the critical angle for this beam? Explain your answer.

17. A rectangular door, 1 m wide and 2 m high and made of uniform material, weighs 180 N. It is supported by two hinges, 0.1 m from the top and bottom, respectively (see below).



Find the horizontal component of force acting on each hinge. Explain the steps in your calculations.

Hint: Equate the clockwise and counter-clockwise torques about one of the hinges as a pivot point.

17. The amount of energy required to enable an object to escape into space from the surface of a planet is called its *binding energy.* The formula for the binding energy is GMm/r, where G is the Universal Gravitational Constant, M is the mass of the planet, m is the mass of the object, and r is the distance from the center of the planet.

The *escape velocity* of an object is the velocity, $v_{\rightarrow e}$, at which the object's kinetic energy, given by $\frac{1}{2}mv^2_{\rightarrow e}$, is equal to the binding energy.

a. Find the formula for escape velocity.

b. Predict how the mass of the planet, the mass of the object, and the altitude of the object will affect its escape velocity.

17. Explain how the degrees of refraction of a beam of light entering water obliquely can be used to determine the speed of light in water relative to that in air?

Draw a diagram to aid in your explanation.

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